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ASSOCIATION OF VALUE AND SIZE FACTORS WITH EQUITY SYSTEMATIC RISK: RESEARCH ON S&P 500 FROM 2013 TO 2018

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Abstract

The purpose of this thesis is to investigate the relation of value and size factor anomalies to the systematic risk of equities. Value and size effects are academically proven market anomalies that have existed on various markets and time periods. Value anomaly refers to the tendency of stocks trading at low price multiples, such as the price to book value of equity (P/B), to outperform stocks trading at higher price multiples. Size anomaly means the tendency of smaller market capitalization stocks to outperform larger market capitalization stocks. For example, Fama & French (1996) and Malkiel (2014) argue that these market anomalies rise from these investment types being exposed to larger than average risk, which would explain the abnormal returns. Because of this proposition, these anomalies are also called risk factors. Investment styles exploiting these anomalies are called factor investment strategies or “Smart Beta” strategies as branded by the investment industry.

Factor investment strategies have become increasingly popular during recent years and there is a wide range of easily available investment vehicles such as ETF:s to employ these strategies. The goal of our research is to investigate if the value and size factor strategies carry with them a higher systematic risk than that of the market. This is done by making a set of regression analyses on the constituent stocks of the Standard & Poor’s 500-index. In the regressions we test for associations between beta and firm size and value factor proxies price-to-book, price-to-earnings, and dividend yield. Value factor proxies are investigated in separate regressions to avoid multicollinearity. The dataset is then further divided into industry sectors and separate regressions are made for each sector to explore for sector differences. The linkage of size effect into large cap S&P 500 stocks can be criticized but we find it relevant to investigate also this factor since the range of company sizes across S&P 500 is by any standards high, with 60-month average market capitalizations ranging from 3 billion USD to 642 billion USD. We aim to answer the question if and how loading an investment portfolio with value or size factor tilts influences the level of systematic risk the portfolio is exposed to.

Our empirical analysis finds that overall the factor proxies do not have an association to either increasing nor decreasing systematic risk. Price-to-earnings ratio, price-to-book ratio, and market capitalization do not have statistically or practically significant relation to beta. Dividend yield has a statistically and practically significant negative association with beta across S&P 500. However, this effect is not observed within separate sector regressions, indicating that the effect across S&P 500 might be caused by sector differences. In short, value and size factor investment strategies do not influence the level of systematic risk of a portfolio except if value factor is proxied by dividend yield, in which case it has a beta decreasing effect.

Keywords

Factor investing, beta, value investing, Smart Beta.

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1 INTRODUCTION

Academic research has found systematic factors in the stock market which provide higher returns versus the overall market. Some of the most well documented of these factors are the Value and Size factors (Fama & French 1993; 1996). The purpose of this study is to research how these two factors are associated with the systematic risk of stocks. The study is based on data from S&P 500-indice stocks for the years 2013 – 2018.

Systematic risk is measured in the study by using the Beta-coefficient which is calculated by using data of the monthly stock and S&P 500 returns from the last 5 years.

The value factor is represented in the study by price-to-book (P/B), price-to-earnings (P/E), and dividend yield (DY) ratios. Size factor is represented by the market capitalizations of the companies.

The motivation for this study comes from investigating the interaction of the Value and Size factors with the systematic risk of the market. Since the value and size anomalies are well documented and publicized, exploiting their excess returns is of interest to investors. For this purpose, there exists a large variety of mutual funds, exchange traded funds and investment strategies for picking individual stocks.

The goal of this research is not to develop a comprehensive model for explaining and forecasting the determinants of beta, but to investigate specifically the possible relation of Value and Size factors to beta.

Our research aims to find out whether loading an investment portfolio with these risk factors influences the portfolio's exposure to the systematic risk of the market. This is important to know for mitigating unknown risks to the portfolio. If our regression analysis finds a positive relation with the risk factors and beta, it implies that adding investments with value and size factor exposures to a portfolio increases the portfolio's systematic risk. Vice versa if the regression analysis shows a negative relationship with these factors and beta, it indicates that adding the factors to a portfolio decreases its exposure to systematic risk.

In our empirical analysis part, we conduct 72 separate regressions to investigate the relation of beta with the factor proxies. The number of regressions is large because we make separate regressions for the whole dataset, each MSCI GICS classified sector, and each factor proxy separately. The factor proxies are investigated in separate regressions to avoid multicollinearity between different value proxies (P/B, P/E, and DY). Accurate description of our data and econometric methodology is discussed in Chapter 5.

This thesis continues in Chapters 2 and 3 by introducing systematic risk, the value and size factors, and previous research contributed on them. Chapter 4 focuses on previous research involving both beta and the risk factors. As mentioned, Chapter 5 is about our data and research methodology. Chapter 6 moves on to introduce our research hypotheses. Chapter 7 shows our empirical quantitative results and discussion about their implications. We conclude the research in Chapter 8 with a summary of our research and its results. Chapter 8 is followed by references and appendices.

2 SYSTEMATIC RISK OF EQUITIES

This chapter introduces systematic risk of equities and one way of estimating it, through a beta coefficient. The chapter discusses academic research conducted on the usage, benefits, and problems of beta. The chapter is not comprehensive, but a brief introduction of the most important aspects. Further research on beta is discussed in chapter 4, where we investigate the theoretical and empirical relation of beta with the value and size factors.

Beta coefficient is a measure which is purposed to represent the so-called systematic risk of a stock. The Capital Asset Pricing Model (CAPM) divides the risk of a stock to firm-specific risk and systematic risk. Systematic risk describes the risk of how much the swings of overall market reflect to the value of a particular asset. If a stock carries a systematic risk similar to the average risk of the stock market in terms of volatility, the stock's beta coefficient value is one. If the stocks riskiness is lower than that of the overall market, its beta is less than one, and a stock which carries a higher risk has a beta above one. A beta of zero implies that a stock carries no systematic risk, meaning that its price has no correlation with the movements of the overall market. A negative beta signifies that the stock tends to move oppositely to the market. Stocks with betas above one are considered aggressive, while stocks with betas less than one are considered defensive. Beta can be calculated also for a portfolio of securities by calculating the weighted average of the individual securities' betas weighted by the portfolio allocations. (Kallunki, Martikainen & Niemelä, 2008: 76-77, 273-274.)

The overall market is usually represented by a broad equity market index, such as the Standard & Poor's 500. If beta is calculated for a company's stock which is listed in another country than the United States it can alternatively be calculated by using that country's local equity index. Equity markets around the world have however become increasingly correlated, which means that for example European stocks face systematic risk also from the downturns of the U.S. market, not just from the local conditions. This has somewhat diminished the effect of international equity diversification. Beta can also be calculated for other assets than equities, such as bonds or commodities. This is done to compare the correlations of different asset classes for diversification purposes. (Driessen & Laeven 2007; Estrada & Vargas 2012.)

Beta is calculated as the covariance between the asset and the market, divided by the variance of the market.

$$\beta = Covariance\ (r_a, r_m)\ \div Variance\ (r_m)$$

Equation 1: Beta equation.

Where β refers to Beta, r_a refers to the return of the asset, and r_m refers to the return of the market. (Rees, 1995, p. 166.)

Since positive betas signify positive correlation with the stock market (S&P 500), investors experience diversification benefits from assets uncorrelated with the market, possessing zero betas. For example, hedge funds can try to create zero-beta portfolios, meaning that in theory they would provide returns regardless of the direction of the overall market. These market neutral portfolios are created by using both long and short positions, or by using arbitrage opportunities (Asness, Moskowitz & Pedersen, 2013). Alternative asset classes are a usual source of claimed diversification benefits, but often even they are highly affected by downturns in U.S. equities, meaning that they have significantly positive betas (Leibowitz & Bova 2007). Gold is an example of an asset that is largely uncorrelated with the stock market, and its returns over a three-decade long period from the 1970s show a zero beta against the U.S. stock market (McCown & Zimmerman 2006). It must be remembered that results of Beta calculations for a security can experience large fluctuations depending on how long return intervals are used (Hawawini 1983).

Beta coefficients of different industries have been found to vary significantly. Stocks of firms operating on industries which are more dependent on the economic cycle tend to possess higher betas. However, this effect is seen on averages of large samples, and the beta coefficients between members of a same industry group can also have a large variation. For a comprehensive listing of betas on different industries see Damodaran (2018).

Because cyclical stocks tend to possess higher betas, it is useful to look at which industries are considered cyclical. An example of categorization can be seen in

Morningstar Global Equity Classification Structure, which divides industries into three Super Sectors; Cyclicals, Sensitives, and Defensives. Cyclicals, which are the most volatile industries comprise sub-sectors of Basic Materials, Consumer Cyclical, Financial Services, and Real Estate. Sensitives comprises of sectors, which are perceived to have average market risk; Communication Services, Energy, Industrials, and Technology. Defensives Super Sector is comprised of the industries which are the least affected by economic cycles; Consumer Defensive, Healthcare, and Utilities. (Morningstar Research, 2011)

Betas of individual stocks have a tendency of regressing towards one from both sides. If a single stock is evaluated with calculating its beta over adjacent 5-year periods, the variation can be significant, meaning that the explanatory power of the previous period’s beta over the next period’s beta is quite low. This coefficient of determination for a single stock is only 0.36 (36%). This is caused to some extent by the stochastic behavior of security prices and by the changes in the firm’s operations during the time span. The low coefficient of determination for betas calculated on adjacent 5-year time periods improves greatly when betas are calculated for larger portfolios of stocks. The previous period’s beta for a portfolio of 50 stocks explains as much as 96% of the next period’s beta. Overall stocks which are indicated by beta to have an extremely high or extremely low systematic risk, tend to move towards a more average risk as time goes by. (Friend & Blume, 1970; Blume, 1975.)

Capital Asset Pricing Model by Sharpe (1964) and Lintner (1965) suggests that stocks with high beta coefficients provide also higher than average returns. Fama & Macbeth (1973) find that this theory holds true on stocks listed in NYSE during the years 1928 – 1968. However, on later years the beta – return relationship seems to have disappeared, which has been seen as an indication that beta is not an adequate measure for expected returns (Reinganum 1981, Lakonishok & Shapiro 1986, Fama & French 1992). This observation has on its part affected to the research on other risk factors that possibly provide excess returns, such as value and size factors on equities. Fama & French (2004) provide a detailed discussion of the various feats and shortages of the CAPM, showing how empirical research has on many parts disproved the theory and set new models for asset pricing, such as the risk factors.

Contrary results to those of Fama & French have also been proposed in research, such as Elsas, El-Shaer & Theissen (2003) documenting statistically significant beta-return relationship in the German stock market, Isakov (1999) documenting the same effect in the Swiss stock market, and Morelli (2007) in the UK market.

Fletcher (2000) investigates beta – return relationship in the stock markets of 18 developed nations during years 1970 – 1998. An analysis of the full period results in a flat relationship between beta and return, consistent with Fama & French (1992). However, when Fletcher breaks the period into subperiods of up- and down-markets, beta – return relationship emerges. Higher beta boosts stock returns in up-markets and worsens the returns in down-markets. This is exactly the way beta is theoretically meant to function in CAPM. Contradictory to CAPM however, Fletcher does not find a significant beta – return relationship spanning across the subperiods. Fletcher's results imply that in the long-run higher beta securities do not earn excess returns, but in the short-run they exaggerate the movements of the broader market in both directions.

Reeb, Kwok & Baek (1998) show that Multinational Corporations (MNCs) are exposed to larger systematic risk than corporations operating only in the U.S. The results are surprising when considering that the beta in the study is calculated in relation to the U.S. market. Montgomery & Singh (1984) try to link beta to various corporate diversification strategies. They find that companies which operate on multiple unrelated lines of business show higher betas. Other types of companies (in terms of operational diversification) tend to have betas around the mean of the market. Estrada & Vargas (2012) take a non-conventional approach to evaluate the usefulness of Beta as a measure of portfolio's systematic risk versus evaluating Betas on single stocks. Estrada & Vargas form high- and low-Beta portfolios from country and industry specific equity indexes, used widely by ETF-products. Their data consists from 47 countries and 57 industries during the years 1973 – 2009. The index Betas are calculated against the returns of the U.S. market. The research finds that low-Beta portfolios perform significantly better than high-Beta portfolios when the market is hit by a crisis (Estrada & Vargas use the term Black Swan, coined by Nassim Taleb). In the post-crisis recovery period, high-Beta portfolios outperform. Overall, the results of

Estrada & Vargas seem to imply that Beta is still a useful risk measure, at least on portfolio-level.

De Carvalho, Lu & Moulin (2012) research five risk-based strategies in forming equity portfolios. They find that these quantitative strategies favor low-beta stocks and that low-beta stocks provide systematically higher returns than predicted by the CAPM. Christoffersen & Simutin (2017) show that pension fund managers respond to pressures of beating their benchmark by overweighting on high-beta stocks to capitalize on rising markets. They analyze that this might create overdemand for high-beta stocks, which would at least partially explain why high-beta stocks underperform relative to the CAPM predictions. Blitz & Van Vliet (2007) show that low volatility stocks earn abnormal risk adjusted returns, and that during 1986 – 2006 this effect was present on U.S., Japanese, and European equity markets. Their results suggest that equity investors overpay for risky stocks versus more stable stocks. On average, lower volatility stocks tend to have also lower betas.

Hänsel & Krahnen (2007) examine how issuing Collateralized Debt Obligations (CDO) affects the systematic risk of banks in U.S. and Europe. They find that issuing CDO's raises the beta of the issuing bank, implying correctly that the bank is exposing itself to heightened market risk. In retrospect this is an interesting result, since credit securitization was one of the triggers for the financial crisis. According to the results of Hänsel & Krahnen it seems that the stock market was aware of the possible risks already before the start of the crisis. The study's results support the role of beta as an adequate measure of systematic risk. Jorion (2009) also notes the failure of sophisticated value at risk (VAR) models to predict the crisis, making the Hänsel & Krahnen results even more relevant.

Campbell, Polk & Vuolteenaho (2005) suggest that different types of stocks (Value and Growth, discussed more in Chapter 3) have different kinds of systematic risk, even though the traditional CAPM considers systematic risk to be similar in nature across all equities. Campbell et al. investigate the cash flow patterns of Growth versus Value stocks and find significant differences. Growth stock cash flows are negatively affected by short term shocks to the stock market, which originate from changing equity risk premiums. Conversely, Value stock cash flows are not affected by the temporary shocks but are affected by permanent shocks to the stock market, which decrease cash flows of the entire market. The research of Campbell et al. implies that the accuracy of a stock's beta as a measure of systematic risk is dependent of the prevalent market conditions and the type of the stock in the Value – Growth spectrum.

Damodaran (1999) lists the three largest problems in using traditional regression betas for the purpose of estimating systematic risk for individual stocks. First, the market index against which the beta is regressed can be overwhelmingly dependent on the movement of just a few large stocks, which is especially true in many emerging markets. Second, the beta estimate can be noisy, meaning that it has large standard errors which in turn raises questions about accuracy. Third, the fundamental characteristics of the firm might have changed during the regression period, changing the exposure to systematic risk. Damodaran suggests a multistage calculation to first analyze the firm's operating businesses and taking into account their leverage, i.e. unlevering betas, to produce a bottom-up beta, which should more accurately represent the stock's systematic risk. We will discuss Damodaran's suggestions and the usage of levered vs. unlevered Betas more in Chapter 5, where we explain our research methodology in detail. It must also be remembered, that beta relates the systematic risk of an individual security to the market but does not offer information of what risks the entire market is facing.

Aside systematic risk, stocks carry also idiosyncratic, or firm specific risk. Kumar (2009) examines U.S. stocks which show lottery-like features. These are the riskiest stocks in the market featuring the largest volatility and uncertainty. Kumar constructs the lottery stock portfolio by identifying stocks with largest idiosyncratic volatility and skewness patterns in returns. On average these stocks are young and small firms, with high P/B ratios and scarce analyst coverage. The beta of Kumar's high-risk portfolio is however only 1.09 (slightly above market average), indicating that the riskiest firms are more affected by firm specific rather than systematic risk. This shows that aside beta, also other risk characteristics of a stock should be examined carefully.

Systematic risk stemming from the global stock markets affects to some extent most of the assets in the world, although for assets that are not constantly traded in exchanges the information of price fluctuations might be hard to obtain and slow to react. Metrick & Yasuda (2012) report research evidence of private equity and venture capital funds having higher betas than the more liquid public markets.

3 VALUE & SIZE FACTORS

3.1 Overview of risk factor research

This chapter introduces academic research on founded stock market anomalies, specifically the value and size risk factors. In the chapter we discuss briefly theories why market anomalies exist, their relation to efficient market theorem, and more deeply focus on research covering the risk factors used in our study. Chapter 4 will combine research done from beta and the value and size factors to interlink previous chapters.

Academic research has documented various factors that have historically provided excess stock returns versus the broader market such as the S&P 500. These factors are also called stock market anomalies, Smart Beta-factors, or risk factors. The name “Smart Beta” comes from the original CAPM proposition which states that a stocks beta should be a major determinant of its expected return; Smart Beta’s name implies that it is a more relevant way to explain excess returns. Investment strategies formed on these kinds of factors are based on academic research, which suggests that tilting the composition of portfolio to match better some known market anomaly will on average produce excess returns versus a market index-based portfolio. These strategies do not utilize active stock picking, but systematic screening techniques to accomplish a relatively low turnover portfolio with low costs and a theoretically sound basis. (Haugen & Baker 1996; Malkiel 2014)

Among the most well documented of these anomalies are value and size factors. These factors have been documented to provide excess returns on various equity markets around the world. These factors seem to also be rather persistent, since their outperformance has been documented on nearly a century-long time-span. Despite this, even the most well documented factors seem to be also somewhat cyclical, meaning that on some time periods they might underperform the broader market. For example, after the financial crisis the value factor has underperformed against the market index. (Bauman, Conover & Miller 1998; Davis, Fama & French 2000; Schwert 2003; Asness et al. 2013; Malkiel 2014; Kawa 2017.)

Value factor refers to stocks that are trading on low price multiples. Value investors look at financial ratios and cash-flows to determine stocks that are “cheap” compared to their fundamentals and peers. Common ratios used in value investing are Price-to-Earnings (P/E), Price-to-Book (P/B), Price-to-Sales (P/S), Dividend yield (DY) and various ratios based on a combination of Enterprise Value and different components from the income statement (EV/EBIT, EV/EBITDA, EV/S). (Fama & French 1998; Visscher & Filbeck 2003; Malkiel 2014; Bodie, Kane & Marcus 2014: 373.)

For example Bauman, Conover & Miller (1998) use P/E, P/B, DY and price to cash flow (P/CF) to identify value stocks from other stocks.

In our study, we use the price multiple approach to determine value factor proxies. This is important to notice, since there is a broad range of valuation techniques, which might yield differing results. Damodaran (2007) classifies the various valuation techniques into four general approaches: discounted cash flow valuation, liquidation and accounting valuation, relative valuation, and contingent claim valuation. Our price multiple usage falls under the relative valuation approach. P/E, P/B and DY ratios are used to compare the valuation characteristics of a stock relative to other stocks.

Price multiples such as the ones used in our study are widely calculated and reported for listed companies. One reason for their popularity is their simple logic and easiness in estimation when compared to valuation models based on discounted cash flows or earnings. However, they do not give as comprehensive estimate of the valuation as more complex models. A value strategy based on screening and ranking potential stocks by price multiples is a variant of passive value investing strategy. (Lev & Sunder 1979; Kallunki et al. 2008: 154, 201-203.)

In academic literature value stocks are usually identified by low price multiples (such as P/E and P/B ratios). Also dividend yield is used as a value proxy. The opposite of value stocks is in the literature often coined as growth stocks, describing stocks that possess high P/E and P/B with a low dividend yield. In practice, investors more often look at projected earnings and revenue growth rates when classifying growth stocks, since necessarily not all stocks trading at high price multiples or low dividend yield are growing businesses. The effect of value investing is theoretically suggested to emerge from market ineffectiveness in pricing securities. This is especially caused by market overreaction to both positive and negative data and news considering specific companies. Negative financial news causes a downward overreaction in stock prices creating “value stocks” and vice versa positive financial news causes upside overreaction creating “growth stocks”. Theoretically the overperformance of value stocks then follows as the markets go through the process of mean reversal, i.e. readjusts the overreacted prices. (DeBondt & Thaler 1985; 1987; Visscher & Filbeck 2003.)

Another model proposed, which seems to explain the overperformance of value and underperformance of growth stocks is, that market participants extrapolate past performance into the future. This means that investors hold high expectations on stocks with a good recent performance and expect poorly performed companies to continue poor performance. When the growth stocks with high price multiples underperform their expectations, their stock prices regress towards the mean. Similarly, when the value stocks with low price multiples overperform their expectations, their prices increase towards the average multiples of the market. This theory is supported by a finding that growth stock underperformance is concentrated on earnings announcement dates, meaning that they categorically fail to meet high expectations. (Lakonishok, Schleifer & Vishny 1994; La Porta, Lakonishok, Schleifer & Vishny 1997.)

Furthermore, noise traders making erratic buy and sell decisions drive the overpriced stocks even higher and the underpriced stocks lower, providing mispricing opportunities to the market (Barber, Odean & Zhu 2006). Barber, Odean & Zhu (2009) also find that retail investors (who are more prone to noise trading than institutional investors) tend to concentrate both buying and selling activity to stocks which have experienced recently extreme gains or losses, providing more evidence that behavioral bias influenced noise trading is a driver of equity mispricing.

In their influential study, Fama & French (1993) use P/B as a proxy of the value factor in their HML portfolio. Value factor is one of the main components of the Fama & French three factor model. In our study we use Price-to-Earnings, Price-to-Book, and Dividend Yield ratios as proxies for the value factor. Size factor refers to the historical tendency of smaller company stocks to outperform larger company stocks in returns. Also, size factor is a main component of the Fama & French three factor model and the base of their SMB portfolio. Overall, Fama & French (1993; 1996) argue that value and size factors are proxies for higher risk, and thus provide on average higher returns over long time samples. Later on, Fama & French (2006a) report that P/B value effect diminishes substantially if profitability is not controlled for. This implies that more profitable firms deserve to be valued at higher P/B multiples. When profitability is controlled for, a strong P/B effect emerges in explaining returns.

Fama & French (1998) report finding a strong value effect (as measured by P/B) in 12 of the 13 major equity markets in the world between 1975 – 1995. They report global low P/B portfolios producing 7,68% higher yearly returns than global high P/B portfolios. They find significant value premiums also when the portfolios are sorted with P/E, DY or P/CF. Also, a size premium is found in international equities. In the same study Fama and French also investigate the stock markets of 16 emerging markets countries during years 1987 - 1995. These include data from nations rarely seen in equity research, such as Jordan, Venezuela and Zimbabwe. Value and size effects are discovered also in emerging markets, but Fama and French do not draw definitive conclusions on these findings because of weakly efficient market mechanisms, low number of stocks in sorted portfolios and short sample periods.

The matter of why and how some of the known market anomalies exist is a subject of debate between different academics and market participants. The question is interesting because of its linkage to the existence of effective markets. Because the value and size anomalies are well documented to historically provide higher returns than the overall market, this can be viewed as a sign of market inefficiency, since if the markets are truly effective, these kinds of anomalies should be traded out of existence. This problem can also be viewed in another light by the traditional framework of extra risk amounting to extra returns. This view hypothesizes that smaller capitalization and lower price multiple valued stocks carry extra risk compared to the overall market. This would explain the existence of these market anomalies, since the return would be a compensation for a higher risk taken by the investors (Fama & French 1993; 1996; Campbell & Vuolteenaho 2004). Because of this theory, different factors that are used to build Smart Beta products are often referred to as risk factors. The notion of differing risk factors leading to excess returns has led to mutually uncorrelated risk premiums being utilized to construct new types of diversified investment strategies (Bender, Briand, Nielsen & Stefek 2010). Bender et al. classify risk premium as the amount an asset is expected to gain for being exposed to a systematic risk.

Malkiel (2014) advocates the proposition that excess returns earned by factor investing strategies are compensation for extra risk taken. He analyzes for example Invesco RAFI ETF (trading ticker PRF), which is a value strategy-oriented exchange traded fund. It had “beaten the index” during prior years and Malkiel wanted to isolate by which trades the abnormal returns were created. Malkiel finds that the ETF produced most of its excess returns during 2009 when 15% of the portfolio was invested in Citigroup and Bank of America stocks. The value strategy eventually worked well in this case, but at the time there was a realistic risk that the equity of these firms would have been entirely wiped out leading to a 100% loss on the two stocks (Malkiel 2014). Zhang (2005) also views value stocks to be exposed to larger risks than growth stocks because of more limited financial flexibility, and thus value premium is a rational reward for carrying risk.

Lakonishok Shleifer & Vishny (1994) analyze the downside risk of value versus growth stocks and find that during the worst periods in the market value stocks decline less than growth stocks. Lakonishok et al. see this as evidence of value factor not adding extra risk, since value stocks seem to possess less downside risk than the overall market. If a stock would be riskier, it should be performing worse than the overall market in bad times.

Although the value and size factors have been documented to provide excess returns in multiple countries and various time spans, even they are cyclical and might underperform on some time periods. Evidence of this can be found for example from Barbee, Mukherji & Raines (1996) who fail to find either P/B or market capitalization to having explanatory power on security returns between the years 1979 – 1991 on the U.S. market. They also suggest using Price-to-Sales ratio as a value proxy instead of the Fama & French-style BE/ME (P/B). Malkiel (2014) discusses effects of mean reversal on factor investing strategies and reports that periods of overperformance are often followed by subsequent periods of underperformance. Malkiel (2014) also states that actual results of factor strategies often differ (underperform) versus simulated expected returns from strategy backtesting. Earlier on, Malkiel (2003) already hypothesized that the value anomaly might have been a phenomenon of the late 20th century, which would not hold permanently.

Capaul, Rowley & Sharpe (1993) find value stocks outperforming the broader market in U.S., Japan, U.K., Switzerland, Germany and France during 1981 – 1992. The value effect however is captured in portfolios consisting of large amounts of securities, and the idiosyncratic risk among individual stocks is high. Thus, Capaul et al. propose that the best way of exploiting the value effect would be through an index fund which mechanically tracks low P/B stocks. The fund should also be internationally diversified, since the yearly value premiums across countries have little correlation with each other, leading to risk adjusted diversification benefits. It seems that Capaul et al. were early proponents of a “smart beta” product before they became mainstream. Capaul et al. also find that value stocks in their dataset tended to have lower betas than their growth counterparts, but often the results were not statistically significant, implying that the effect of value factors to beta is negligible.

Freeman (1991) criticizes backtested investment strategies altogether, and recounts that even poorly constructed value and size strategies would have performed well during the 1980’s but implies that this does not mean that their good performance in the future would be evident. The increases in amounts of data and computing power have led to researchers being able to identify correlations which seem to predict stock returns or some other variable, even though their theoretical background might be thin. This might lead to finding correlations without causation; relationships between variables that seem to have predictive power within the dataset, but which are nonsense outside the dataset. Lo & MacKinley (1990) criticize tendency of some researchers and practitioners to overinvestigate and overfit data models to produce meaningless investment strategies. Freeman (1991) summarizes:

“Given both intentional and unintentional biases in (investment) strategy development it is not unreasonable to assume that for every four completely informationless strategies tested over a year, one will appear statistically significant.”

The data snooping critique by Freeman (1991) is countered by Barber & Lyon (1997) who confirm the value anomaly results of Fama & French (1993; 1996) and Lakonishok et al. (1994) on a holdout sample not included in the previous researches. Barber & Lyon find the value and size factors to produce economically meaningful excess returns and dismiss the proposal that they would be a product of data mining. Further on, Davis, Fama & French (2000) show the value and size anomalies to exist on a long dataset from 1929 to 1997 in NYSE stocks. Value anomaly produces stronger excess returns than size, but both are statistically significant and economically meaningful. Bauman, Conover & Miller (1998) confirm that the value effect exists globally on a 21 country spanning dataset from 1986 to 1996.

Cohen, Polk & Vuolteenaho (2003) show that value strategies are most profitable when the market is trading at low price multiples and when the value spread is high. They define value spread as “the difference between the book-to-market ratio of a typical value stock and a typical growth stock”. The research of Cohen, Polk & Vuolteenaho reinforces evidence of the cyclicality of investment strategies. Vuolteenaho (1999) also finds that the aggregate book-to-market ratio of the stock market is high (P/B low), when the risk premium of equities is high. Deriving from these studies implies that value strategies are most profitable when the entire market is perceived to be riskier than on average (e.g. political or macroeconomic risks).

Petkova & Zhang (2005) investigate time varying market risk models. They find that value stock betas tend to covary with market risk premium while growth stock betas covary negatively with risk premium. This implies that value stocks’ systematic risk increases when uncertainty in the market increases and vice versa for growth stocks. Petkova & Zhang interpret from their results that time varying models help explaining value anomaly to some extent, but not entirely. Results of Petkova & Zhang are conflicting with the results of Lakonishok et al., who argue that value stocks do not expose to excess downside risk in down-markets.

Liew & Vassalou (2000) researched the value and size factors relation with GDP growth in a set of industrialized countries. They find that strong value and size anomaly stock returns precede strong GDP growth by a year. Liew & Vassalou interpret this as evidence that the anomalies might capture a business cycle risk factor not identified previously.

Elton, Gruber, Brown & Goetzmann (2011: 413) list the various theories academics have proposed to explain the existence of market efficiency defying anomalies, such as value and size factors. They classify the theories into five categories:

- The anomalies serve as a proxy for an omitted risk variable, i.e. they are risk factors.
- The anomalies are not real, but instead a result of the research design and dataset, i.e. data mining.
- CAPM contains misestimations, which systematically produce too low betas for small firm stocks. If betas would be estimated properly, betas would have a high explanatory power over returns. Note that this proposition applies only to size anomaly.
- The anomalies remain because exploiting them would not produce excess returns after trading costs. Especially small cap stocks can be too illiquid to invest in for institutional investors controlling billions of euros.
- Market inefficiency. Markets simply might be ineffective in pricing securities, even though plenty of research evidence is available on risk factors.

Elton, Gruber, Brown & Goetzmann (2011: 450 – 452) also discuss behavioral reasons, such as disposition effect, overconfidence, prospect theory, and representativeness heuristic, which are examined in financial literature to affect security mispricing, thus creating market anomalies. For a comprehensive analysis of behavioral heuristics creating market irrationality, see Hirshleifer (2001).

Since the discovery and widespread knowledge of value and size effects, there has been a surge in asset pricing literature trying to explain the reasons behind the anomalies with various statistical models. According to Lewellen, Nagel & Shanken (2010) The problem with a lot of these models is that they find a partly omitted variable in relation to P/B or size effect, which then produces a falsely high R-squared (coefficient of determination) and seemingly explains the anomaly. Lewellen et al. suggest setting a higher standard to testing of asset pricing models to avoid statistical errors. This can be done by backtesting the models with a larger variety of differently constructed portfolios and datasets and exploring the theoretical background carefully to avoid spurious regressions.

A possible example of spurious regressions and / or data mining can be seen for example in asset pricing literature trying to link corporate social responsibility (CSR) to financial performance. Different researchers have found either positive, negative, or neutral effects between CSR and financial performance. These kinds of conflicting and mixed results are due to econometrical failures and aggressive interpretation of results without considering possible problems in the research design. Generalizability of these results is obviously poor, when research results are as mixed as in this case. (McWilliams & Siegel 2000.)

Even though many market anomalies are well documented academically, making a profit by trading on them seems to be challenging even for professional investors. Malkiel (2005) makes a comprehensive study of actively managed investment funds in U.S., Europe and emerging markets. He finds that for example in large cap U.S. equity funds, over any given time span (1, 2, 5, 10, or 20 years), the majority of actively managed funds (73% – 90%) lose to their benchmark index after adjusting for fund management fees. Malkiel states that even these statistics are biased in favor of actively managed funds by containing a large survivorship bias, since many of the worst performing funds have been terminated or merged into better performing funds to show a better track record. Malkiel also finds that individual fund performance has poor persistence, since on average funds which have the best performances over a period in Morningstar ratings tend to have poor performances over the next adjacent period. Malkiel's results imply that many of the anomalies found by academic literature tend to be observable only in hindsight, and it is difficult to estimate how the markets function in the future by relying on data which is drawn from the past.

3.2 Regression model independent variables: Price-to-Book, Price-to-Earnings, Dividend Yield & Market Capitalization

Here we go through a brief introduction of the independent variables used in our empirical analysis part.

Price-to-Earnings ratio is a commonly used and reported value proxy, used both by practitioners and academics. It is a simplistic measure calculated by dividing the current stock price by the current earnings of the company. Alternatively, P/E can also be calculated by using forward estimate of earnings or trailing earnings as the divisor.

Basu (1977) documented the existence of P/E anomaly in NYSE stocks during the period 1956 – 1971. He constructed portfolios of low P/E stocks and rebalanced the portfolios annually. Low P/E stocks earned excess returns against the entire market on both absolute and risk-adjusted terms, even after taking into account transaction costs and taxation. Basu concludes that the market does not efficiently price in all the relevant information into stock prices, which allows value stocks to outperform.

The largest single factor affecting P/E ratios is expectations about future revenue and profit growth. If the expectations of future profits are high, also the current P/E ratio should be high when compared to a firm with lower growth prospects. Riskiness of the firm should be reflected in P/E ratio, so that investors are willing to pay a higher price multiple for smaller risk and vice versa. When compared to P/B, P/E tends to be volatile because the divisor of the equation (earnings) can experience large annual changes. (Kallunki et al. 2008: 159.)

Price-to-Book is the most common value factor proxy in academic research. P/B is calculated as the company's market value divided by its book value of equity. The significance of P/B ratio in value factor research was cemented by the influential series of Fama & French studies in the 1990's.

Fama & French (1993; 1996) document that stocks which trade at a high BE/ME ratio provide excess returns versus the overall market on U.S. stock exchanges. The BE/ME ratio used by Fama & French is a reversed version of the P/B ratio used in our research.

The results of Fama & French are widely published, and they indicate that the value factor (low P/B) produces higher returns than predicted by the CAPM.

Profitability of the business (ROE, ROA, etc.) has a large effect on the P/B ratio. Highly profitable businesses have high P/Bs and vice versa. If a company's ROE is equal to its cost of equity, P/B ratio should be 1. Higher ROE produces P/B values above 1 and if ROE falls below the cost of equity, P/B should reflect this with values under 1. (Kallunki et al. 2008: 168-169.)

Cakici, Tang & Yan (2016) find that value effect (as measured by P/B ratio) provided excess returns on emerging markets during 1990 – 2013. Low P/B portfolios performed well across the whole period and also during market turbulences, such as the 2008 financial crisis. The dataset consisted of 18 emerging markets countries as classified by MSCI and the only market where value effect did not appear was Brazil. Gaunt (2004) shows P/B effect on the Australian stock market. Gaunt also theorizes that low P/B stocks produce the best value effect when they are sorted also on ROA, so that stocks combining low P/B and high ROA are chosen. According to Gaunt this will reduce the risk of investing in low quality firms that might be selected through P/B screening.

Morelli (2007) finds P/B value effect in the UK market. Kothari & Shanken (1997) find low P/B stocks to produce excess returns in the U.S. market 1926 – 1991. In the same study, Kothari & Shanken do not find dividend yield to be a factor influencing returns.

Novy-Marx (2013) finds that screening stocks with firm profitability, as measured by gross profits divided by assets, provides similar excess returns as P/B value strategies, and utilizing simultaneously both low P/B and high profitability screening yields better results than using only P/B screening.

Dividend yield (Dividend / Share price) is a commonly used metric to screen stocks in investment research. Dividends are an important component of many valuation models, such as the Dividend Discount Model.

Ang & Bekaert (2006) state that the “conventional wisdom” among investment literature tells that high dividend yields have a strong predictive power of high aggregate stock returns. Their research on U.S. and Western European data however disputes this belief and indicates that dividend yields have some predictive power on returns at short time horizons, but that this effect diminishes on longer time horizons.

Visscher & Filbeck (2003) find mixed results on the effectiveness of high dividend yield strategies on Canadian data. Interesting to our research however is, that Visscher & Filbeck find that the high dividend yield strategy’s Sharpe and Treynor ratios outperform that of the market index. Since Treynor ratio is denominated by Beta, this finding suggests that on the Canadian market a high dividend yield correlates negatively with Beta.

Hecht & Vuolteenaho (2005) find that dividend growth has a relatively strong explanatory power to cash flow growth, i.e. it is a cash flow growth proxy. Since corporate management generally is reluctant to cut dividends, a high dividend yield can be seen as management confidence to be able to generate at least similar cash flow also in the future. This suggests to our research that dividend yield should affect Beta decreasingly.

The size factor is represented in our study simply by the market capitalization of the firms in our data set. Fama & French (1993; 1996) show that stocks with smaller market capitalizations provide higher returns versus stocks with higher market capitalizations. Possible explanations include that smaller companies have larger growth opportunities or that they carry higher risk, which in turn results into higher average returns. Banz (1981) had already earlier showed the overperformance of small versus large firm stocks in the U.S. market.

4 RELATIONSHIP OF BETA & RISK FACTORS

This chapter focuses on academic research conducted on the relation of beta coefficients with value and size factors. We will utilize research directly linking the subjects and synthesize results and theoretical basis from other research. Foundation for the chapter is research discussed in chapters 2 and 3. Even though beta and the risk factors have both been researched extensively in academic literature on their own, they are mostly studied separately of each other's.

Both beta and the risk factors (value and size) have been researched thoroughly in academic literature. The most extensive research on beta has been conducted during the 1980's and 1990's, when the role of beta in financial literature seems to have been more important than today. Subsequently other measures, such as Value-at-Risk modeling have gained popularity as measures of portfolio's riskiness, and academic research on betas seems to have been in decline, even though betas are still widely estimated and published by different investment research firms. For example, Google Scholar finds more academic papers with Beta-related searches for recent years than for the 1980's or -90's but the papers have much less citations and are usually published by researchers outside the United States, while the earlier decades' beta research was widely U.S. driven.

Value and size factors have been reported in academic literature already in the 1970's and 1980's, but they started to gain more attention after Fama & French (1993) published their three-factor model. Afterwards the practical implications of these risk factors have led to a widespread adoption of the research results into investment strategies and products.

The original proposition of beta in the Capital Asset Pricing Model was that increased systematic risk would imply increasing average returns. However, this proposition has been denounced in academic literature (Fama & French 1992; 1996), which has on its part probably influenced to the declining interest in beta in academic literature. However, beta can still be used as a measure of systematic risk even though higher beta wouldn't imply higher expected returns. CAPM itself and its empirical failure have also received a lot of criticism in academic literature (Fama & French 2004).

Beaver, Kettler & Scholes (1970) investigate the relationship of various accounting variables and beta on the U.S. market. They find that large firms (as measured by assets) have lower betas than small ones. This approach is a bit different than our market capitalization-oriented size factor, but it might implicate also that smaller market capitalization firms face higher systematic risk. Since companies with large assets often tend to operate on industries with relatively low margins and ROE's, this result might also suggest that firms with low P/B ratios face lower systematic risk.

Beaver et al. also find that high dividend payments (portion of earnings paid out in dividends) reduce the beta of a stock. This is hypothesized to happen because of two reasons; corporate management is usually extremely reluctant to cut dividends, meaning that dividends signal a confidence by the management to the future performance of the firm, and that investors might view dividends as less risky than capital gains, implying that high dividend stocks should face smaller beta.

Beaver et al. make also several other interesting findings in their research about the relationship of beta and various accounting factors:

- Growth is associated with higher beta
- Leverage is associated with higher beta
- Liquidity decreases beta (Current ratio)
- Variability of earnings increases beta, strengthening the observation that cyclical firms and industries have higher betas.

Gu & Kim (2002) investigate the beta determinants for U.S. listed restaurant companies. They include quick ratio, ROA, total assets, equity ratio, EBIT growth, asset turnover and dividend yield as independent variables to their regression analysis. The explanatory power of their model was however low (0,315) when compared to the excessive set of variables considered. They found statistically significant relationship in high asset turnover reducing beta and high quick ratio increasing beta. High asset turnover indicates efficient use of capital, but it is hard to theoretically justify why good liquidity (quick ratio) would increase systematic risk. Therefore, the results seem to at least partly be caused by randomness.

The determinants of beta can be analyzed on differing variables for different industries. Lee & Jang (2007) for example investigate the beta determinants for U.S. airline carriers. They find that systematic risk is decreased with high profitability, growth and flying safety, while it increases with leverage and firm size. The notion of firm size increasing beta is contrary to Beaver et al. (1970) and might be unique to the industry or a result of small sample size.

Kim, Gu & Mattila (2002) investigate beta determinants for U.S. hotel REITs (Real Estate Investment Trust). They find that most of the volatility in hotel REIT stocks cannot be explained by systematic risk, meaning that the firm-specific risk accounts for most of the fluctuation. The systematic risk was correlated positively with leverage and growth. Similarly to Beaver et al. (1970), Kim et al. find larger firm size to reduce beta.

The association of high beta to certain risk factors might also experience changes over time. For example, the Beaver et al. (1970) study reports smaller firms (as measured by assets) to have a higher beta, but during the fears of a U.S. - China trade war during Spring 2018, U.S. investors seemed to rotate from large cap into small cap stocks (Sindreu, 2018). This would not make sense if investors viewed this group of stocks to pose a higher systematic risk than that of the overall market. Therefore, it seems empirically that investors viewed small cap stocks to possess a smaller systematic risk in the particular situation faced by the markets, which was due to smaller international exposure.

Amit & Livnat (1988) show that firms which have diversified their operations to multiple business sectors have on average lower betas, supporting the notion that different sectors have differing betas, and that diversification of business segments might reduce the systematic risk by decreasing cyclicality.

Bowman & Bush (2006) investigate the usage of Comparative Company Analysis (CCA) to estimate Betas of non-listed companies in the U.S. market. They find that when firm size is controlled for, the CCA technique obtains reasonably accurate results. They also find that including dividend payout and operating leverage further increases the accuracy of their analysis. The research of Bowman & Bush implies to our research, that the Size and Dividend Yield factors would be relevant in determining beta. The matter of possible omitted variable bias (OVB) which might be caused by leverage-factor is addressed later, in Chapter 5.

Jegadeesh (1992) does not find proof that smaller companies would carry excess market risk. Thus, Jegadeesh does not see the size effect as a risk factor, but as a market anomaly caused by market ineffectiveness.

Chatterjee & Lubatkin (1990) investigate the effect of corporate mergers and acquisitions on the systematic risk of the acquiring firms. They hypothesized that the more related the two combining businesses are, the more they would accomplish synergies and reduce beta. Chatterjee & Lubatkin however find that M&A in general tends to lower beta, not being dependent on the relatedness of the businesses. Regarding the theoretical base of our research, results from Chatterjee & Lubatkin imply that firm size correlates negatively with beta.

Eun & Huang (2007) investigate return patterns and market rationality on Chinese stock market. They find that beta has no effect on returns while value factors (dividend yield and price-to-book) and size factor produce excess returns. The study's results imply that beta is not related to value and size factors in the Chinese stock market.

Lui, Markov & Tamayo (2007) study stock risk ratings from sell-side analysts. They find that a stocks beta increases when analysts adjust its rating to riskier. This implies that analyst ratings influence the perceived riskiness of stocks, and the market reacts more strongly to news on stocks with poor analyst ratings. Lui et al. also find that stocks which are rated riskier possess on average lower P/B ratios than rest of the market. The low P/B ratio in this case implies that the market is not confident in the future earnings prospects of these firms, which leads their stock prices to trade at low multiples compared to assets. In relation to our research, Lui et al. study's results imply that high beta is associated with low P/B ratio.

Rozeff (1982) finds in his research of U.S. stock market that firms paying high dividend payouts have significantly lower betas. Melicher (1974) studied U.S. electric utility firms and found dividends having a negative correlation with beta and firm size having a positive correlation with beta.

Heston, Rouwenhorst & Wessels (1999) investigate the effects of beta and size factor on stock returns in 12 European markets during 1978 – 1995. They find that beta is positively correlated with returns and size is negatively correlated with returns. However, when Heston, Rouwenhorst & Wessels investigate the relation of beta and size factor, they find that they are not related with each other, although both are producing return premiums.

Ho, Strange & Piesse (2006) investigate risk premiums of beta, P/B and size factors in the Hong Kong stock market during 1980 – 1998. They find that over time higher beta stocks do not produce excess returns, but low P/B and low market capitalization stocks do. Ho et al. break up the dataset period into up and down markets. They find that high beta stocks overperform in up markets and underperform in down markets. Low P/B stocks overperform in up markets and perform similarly to the overall market in down markets, while low size stocks perform similarly to overall market in up markets and overperform in down markets. The results are inconclusive of any relation between beta and the risk factors.

Harris & Marston (1994) investigate the determination of P/B ratios on base of betas and firm growth rate in U.S. stocks. They find that beta has a negative correlation with P/B, once growth is controlled for. If growth is not controlled, the results are insignificant. Harris & Marston hypothesize that markets price stocks facing high systematic risk with low price multiples, leading to the low P/B stocks having a high beta.

Fama & French (2006b) investigate the validity of CAPM in U.S. and 14 foreign markets. According to CAPM, higher beta stocks should produce higher returns. Fama & French find that during 1926 – 1963 the value premium was explained in the U.S. by higher betas, but on the 1963 – 2004 period value stocks (measured by P/B) have lower betas than growth stocks. Fama and French find also that during 1926 – 2004 small firms tend to have higher betas than large firms in the U.S. market.

5 DATA & METHODOLOGY

This chapter introduces the research method of our regression analysis and the data used. We attempt to describe our research in such detail and transparency that the results can be replicated. In the chapter we explain reasons for the choice of datasets, investigated variables, and every econometric choice of method made in the analysis. We discuss possible problems and other issues regarding our data or the regression analysis, and how we have addressed them. We also discuss various aspects of the regression analysis technique and its compatibility with our data.

The set of stocks used for the data of this study are the stocks of the Standard & Poor's 500 Index. The S&P 500 is a market capitalization weighted index which consists of the stocks of the largest 500 US companies which are publicly traded in NYSE or NASDAQ. S&P 500 is one of the most widely followed equity indexes in the world.

The data collected for the variables covers the period of 25.5.2013 – 25.5.2018. The time period was chosen because we started our data analysis part on 26.5.2018 and wanted to use as recent data as possible. Including the start of the year 2018 to our analysis was also justified because of the increased volatility of the US stock market compared to earlier years, which in turn might have an effect on our Beta calculations. This would be valuable to the research since Beta is supposed to capture the systematic risk of a stock, which might not entirely be reflected during a long upside market, which the U.S. has experienced during recent years (Petkova & Zhang 2005). The length of the time period researched is 5 years because the standard method for calculating beta coefficients in academic literature is to calculate them from trailing 60 months returns of the individual stocks and the market index.

For the calculation of beta coefficients, we have collected monthly returns for the S&P 500 index and the individual stock constituents of the index. In the regression model beta is the dependent variable and Price-to-Book, Price-to-Earnings and Dividend Yield ratios are used as independent variables for the value factor and market capitalization is used as the independent variable for the size factor. We have collected the 5-year monthly data also for each of the independent variables and calculated the arithmetic mean for them between 25.5.2013 – 25.5.2018. The reason we use the 5-

year arithmetic mean rather than for example the closing value is because the betas have been calculated using the 60-month data, so this way the independent variables we use in the regression match the corresponding way of estimating the dependent variable. All data are collected from Thomson Reuters Datastream. Monthly returns are calculated from monthly stock and index prices on the 25th day of each month. The list of firms comprising the S&P 500 is received from the holdings list of State Street Global Advisors SPDR S&P 500 ETF Trust (ticker: SPY).

We will make separate linear regression analyses for each of the independent variables to test their relationship with the equivalent betas. We make separate analyses for the variables because the theoretical background gives us reason to believe that the value proxies P/E, P/B and DY might encounter multicollinearity problems in the analysis which would negatively alter the reliability of our research's results (Chen & Shimerda 1981). Multicollinearity means that the independent variables are highly correlated with each other's. This produces problems with estimating the standard errors and a combination of multicollinear independent variables might produce falsely low estimates of p-values indicating false statistical significance. The fact that we make separate regressions on each of the independent variables reduces the explanatory power of the regressions, but this is not a problem since we do not aim to produce a comprehensive model to fully estimate the beta determinants. Instead, our research aims to answer if and how loading investment products utilizing value and size factor anomalies affects the systematic risk of a portfolio. The investigation of three separate value proxies, P/E, P/B, and DY is useful because different market participants use different proxies for the same risk factor (Chen & Shimerda 1981).

In the regression analysis part of the research, the dataset for the first set of regressions is the entire set of stocks. In the subsequent regressions the dataset is divided to separate industry classes. The dependent variable is always the beta coefficient. Each regression analysis has one independent variable, which is either P/E, P/B, DY, or Size (MV). The regressions are performed so, that for each industry sector and the entire dataset, there is a regression for each of the independent variables.

The reason we use the variables we have chosen is because of simplicity, reliability, and availability of data. Size factor is simply represented by the market value of the companies, since this is clearly the most relevant and used variable in academic research. Value factor is represented by three separate variables, P/B, P/E and DY, since all these variables are used in academic literature as proxies for the value effect. By investigating three different variables we can also examine if some of the variables are more or less related to beta. Value factor could possibly be represented more accurately by some other more sophisticated measures, but the theoretical background would become thinner and problems of data mining might emerge (Lo & MacKinley 1990).

As mentioned, size anomaly is represented in our study by the market value of the companies. It should be remembered however, that our dataset consists of S&P 500 stocks which all have large market capitalizations. The 60-month average calculations used for the independent variables in the study's regression model give the datasets stocks' market capitalizations between a low of 3,2 billion USD and a high of 642 billion USD with a mean of 38,3 billion USD and a median of 18,2 billion USD. Therefore, the dataset of our study does not include stocks that would be defined as Small Cap-stocks. However, the range of market capitalizations in the dataset is extremely large and therefore suitable for investigating the Size factor and its possible relationship with beta.

We have chosen the S&P 500 index as the dataset for the study since the market for U.S. large capitalization stocks is arguably the most efficient equity market in the world, making the results of the study more replicable. Reinganum (1981) shows that stocks which trade with smaller volume will have a downward biased beta estimate because of nonsynchronous trading and large trading spreads. Cohen, Hawawini, Maier, Schwartz & Whitcomb (1983) argue that the ordinary least squares regression (OLS) used to calculate betas categorically underestimates them for small companies. This happens because small company stocks are less liquid and trade less frequently, leading them to easily experience large swings in value, caused even by a single large buy or sell order. Cohen et al. suggest that this asynchronous trading misleadingly makes the OLS beta regressions to appear as less correlated to the market, even though the actual systematic risk faced by these stocks should imply a much larger beta. These concerns should however be limited in our sample, since even the smallest market capitalization stocks of our dataset are large in capitalization and liquid in trading activity. S&P 500 stocks are among the most liquid assets in the world combined with the lowest information asymmetry. If our research shows significant results, it is more likely that these results can then be replicated on other datasets, e.g. foreign stocks, or small cap stocks, than would be the other way around.

In terms of gathering the data, replicability should not be an issue since the information needed to calculate betas and our factor ratios is widely available on different historical time frames and different asset classes. One possibility is however, that highly liquid S&P 500 stocks might possess different characteristics in their systematic risk and risk factor characteristics than for example emerging markets stocks, which would mean that even an identically replicated study would find differing results on differing data. Therefore, the question of sampling error does apply if the study's results are being utilized on a different set of data. However, sampling error does not apply on the research's results itself because it uses the entire applicable dataset (S&P 500). The generalizability of our research's results would most likely apply to other equity classes which trade on highly liquid markets and are affected by a closely similar regulatory environment.

Due to changes in the S&P 500 index composition during the research period, some of the companies which are currently included in the index have been added later than 25.5.2013. This means that we were not able to calculate a beta coefficient for these stocks, since this would have required us to estimate their betas from shorter trading periods. This would have caused asymmetry to our data, so we decided to exclude these stocks from our data. The number of these stocks was 17. We also excluded three stocks because of lacking P/B data, one stock for lacking P/E data and one stock for lacking data of all the independent variables. Three stocks were also excluded for having a continuously negative P/B-ratio for the entire research period. For more information about how we deal with negative ratios in the regression analysis, see the next paragraph. The total number of stocks excluded from the regression analysis due to missing data is 25. The regression analysis part is performed with 475 stocks. (See Appendix 2 for full list of excluded stocks.)

The aspect of negative observations for independent variables and how to deal with them was a considerable issue for the research. P/E and P/B ratios are calculated by dividing the stock price by earnings and book value of equity. If the earnings are negative for a period, P/E ratio will become a negative number and similarly if the book value of equity is negative the P/B ratio will be negative. Our research method involves calculating the arithmetic mean of 60-month observations for the independent variables. Negative observations will distort our data, since they will decrease the P/E and P/B ratios, even though their practical implication is exactly the opposite. The error might cause stocks with largely negative earnings and book value to appear as value stocks on the base of the biased ratios, while they are in fact right at the other end of the value – growth spectrum. The problem could be avoided by using opposite E/P and B/P (B/M) ratios. However, since P/E and P/B ratios are more widely used in practice outside academic literature, we decided to use these measures and control for the error within our study. Usage of P/E and P/B ratios makes the results more easily interpretable because of their widespread practical adoption.

We control for this negative observation error by taking into account only the positive P/E and P/B observations when calculating the arithmetic means (averages). Then the average is calculated by dividing on the amount of used observations. The period 25.5.2013 – 25.5.2018 contains 61 monthly observations for each stock's each variable. Therefore, the standard procedure for calculating an individual stocks' 60-month P/E or P/B average is calculated by summing 61 positive value observations and dividing the sum by 61. If a stock has for example 11 negative observations for P/E or P/B, the average is calculated by adding the 50 positive observations and dividing the end result by 50.

Our control model in calculating P/E and P/B averages is not perfect since it does not take the months with negative observations into account. However, by examining the data we find that the stocks with multiple negative observations mostly have extremely high P/E and P/B ratios for the positive observation periods. This means that the characteristics of these stocks are not changed significantly by our research method. The stocks which have some of their observations excluded will show on the growth end of the value – growth price multiple spectrum, even after the adjustments. Thus, the control measure does not produce material distortion to our variables for the regression analysis. (See Appendix 1 for full list of stocks and variables)

The regression analyses are performed on Microsoft Excel. Excel is not as powerful statistical software as for example SPSS, but it is suitable for our analysis. As described above, our study involves performing separate regression analyses with each of the independent variables, first for the entire population of stocks, and subsequently for stocks grouped by sector. The sectors are the following: information technology, financials, health care, consumer discretionary, consumer staples, industrials, energy, utilities, materials, and real estate. Sector classifications for the S&P 500 component firms are from the SPDR SPY – ETF. An additional sector in the S&P 500 is also the telecommunications sector, but since S&P 500 contains only 3 telecom stocks (AT&T, Verizon Communications, and CenturyLink) they are included in the regression set of the entire dataset, but we do not perform a separate regression set for telecom sector.

S&P Dow Jones Indices and MSCI made an overhaul to the industry classifications in September 2018 (Randewich, 2018). In the changes, various companies previously classified in the Information Technology sector were moved to a renamed Communications sector (ex-Telecom sector). Our study utilizes the old sector classifications, used before the overhaul. This is simply because we downloaded our data from Thomson Reuters Datastream in May 2018, when the old classifications were in place.

The analyses covering the entire S&P 500 will show if beta is related to our independent variables across the U.S. large cap equity market. The separate sector analyses will control for industry effects by investigating if beta is related to the independent variables differently on stocks from differing sectors. The multicollinearity problem is controlled by separate regressions for the independent variables.

One other statistical issue we must consider is that of Omitted Variable Bias (OVB). Since academic literature has occasionally found also other factors than value and size which affect beta, it is possible that if we find a relationship between the variables in our research, it might be caused by an omitted variable which is correlated with our independent variables.

Beaver et al. (1970) found effect on beta from the variables of growth, liquidity, leverage and cyclicality (See Chapter 4). They also found effect from asset size and dividend yield. The last two mentioned are captured in our research, while also cyclicality is to some extent controlled for by our division of the dataset to sectors. High growth firms have on average higher price multiples, which might imply that our value factor negatively captures the growth factor's effect on beta. Liquidity and leverage remain factors which our study does not control for, so the possible OVB caused by these factors will stay as a matter to be addressed by future research.

The effect of leverage increasing beta is also supported by researches by Hamada (1972), Amit & Livnat (1988) and Faff, Brooks & Kee (2002).

In Chapter 2 we discussed criticism by Damodaran (1999) towards beta as a measure of systematic risk. The problems presented by Damodaran are however limited in our research. Damodaran criticizes the overdependence of smaller indexes (used in the beta regression) of a few large stocks. This effect is decreased by the usage of S&P 500, where the price movement of a single stock does not produce large fluctuation. The effect of changing company fundamentals during the regression period is also captured in our study, since we use a 60-month average calculation for the independent variables considered. Damodaran's criticism about large standard errors in beta estimates remains to be addressed.

Damodaran (1999) also suggests controlling for leverage effect on systematic risk by using unlevered beta calculations. In our study, we use the traditional OLS regression beta. We do this because we want to examine the possible effects of value and size factors on systematic risk. Value and size factors do not consider leverage, which means that if leverage is an omitted variable, it should not be controlled for on the dependent variable either to produce an unbiased regression. If the independent variables have OVB from leverage effect it is not a problem to our research, but an issue which might be possibly useful to research in a separate study. The OLS regression beta is a standard measure reported in various investment purposes. When market participants screen for assets capturing value and size factors, we find it unlikely that they would simultaneously screen for unlevered beta estimates, which are hard to find. The practical usage of the standard beta and the fact that we do not control for leverage effect on the independent variables, leaves the standard beta as the best systematic risk estimate to use in our regression.

In previous chapters we have discussed potential problems associated with data mining. An excellent demonstration of the possibilities and dangers of data mining can be seen by Leinweber (2007) in his brilliantly titled article: “Stupid data miner tricks: overfitting the S&P 500”. We must be aware of the possibility to produce falsely statistically significant models also in our research. This means mapping our theoretical base carefully to investigate reasonable variables to begin with, and not interpreting our results in a too aggressive manner. We have selected our independent variables and dataset to be as widely used metrics as possible to increase the representativeness of our results.

Below in Table 1 we can see descriptive statistics for the regression variables.

Table 1: Descriptive statistics for the regression variables.

	Beta	*PB*	*PE*	*DY*	*MV*
Mean	0,99	8,63	59,20	1,86	38266
Standard Error	0,02	2,30	13,10	0,06	2749
Median	0,99	3,30	24,55	1,87	18197
Mode				0,00	
Standard Deviation	0,42	50,23	285,48	1,34	59921
Sample Variance	0,17	2522,87	81498,61	1,80	3590498573
Kurtosis	2,59	418,22	239,11	0,19	30,08
Skewness	0,64	19,91	14,82	0,44	4,57
Range	3,48	1066,11	5087,33	7,99	638460
Minimum	0,02	0,79	10,51	0,00	3176
Maximum	3,50	1066,91	5097,84	7,99	641636
Sum	470,82	4098,18	28117,63	882,79	18176480
Count	475	475	475	475	475

Skewness and kurtosis are extremely high for both P/B and P/E variables. This means that their distribution is far from the normal distribution (Skewness 0, Kurtosis 3). They both have an asymmetrically skewed distribution with a long right tail. Left tail is limited to the value of zero. The long right tail in P/B and P/E distributions is caused because of these ratios “exploding” if the ratio divisor (earnings or book value of equity) is extremely small.

From the descriptive statistics (Table 1) we can see that the maximum values for P/B and P/E are 1066,91 and 5087,33. By comparing these to the means and the medians (and by using common sense) we can easily see that these are huge outliers, which will probably have a distorting effect in the regression analysis.

To mitigate outlier bias in our regression analysis part, we trim (truncate) the dataset by removing 1% of highest P/B and P/E stocks from the dataset. This means removing 5 stocks with highest P/B and 5 stocks with highest P/E values. There is no overlap between these two sets of outliers. This reduces the number of observations for the whole dataset from 475 to 465. The trimmed outlier observations can be seen in tables 2 and 3.

Table 2: Stocks excluded from the dataset after trimming for 1% of highest P/B stocks.

Company	Identifier	Sector	Beta	P/B	P/E	DY	MV
L Brands Inc.	LB	Consumer Discretionary	0,81	1066,91	19,13	3,21	18978
Boeing Company	BA	Industrials	1,27	144,07	21,56	2,60	108088
H&R Block Inc.	HRB	Consumer Discretionary	0,52	105,95	19,64	3,02	7147
Nektar Therapeutics	NKTR	Health Care	1,08	103,01	138,82	0,00	3176
United Parcel Service Inc. Class B	UPS	Industrials	0,92	88,77	33,67	2,87	72470

Table 3: Stocks excluded from the dataset after trimming for 1% of highest P/E stocks.

Company	Identifier	Sector	Beta	P/B	P/E	DY	MV
S&P Global Inc.	SPGI	Financials	1,23	61,90	5097,84	1,35	28956
salesforce.com inc.	CRM	Information Technology	1,09	8,65	3275,78	0,00	49751
EOG Resources Inc.	EOG	Energy	1,44	3,35	940,39	0,67	50726
A. O. Smith Corporation	AOS	Industrials	1,44	4,51	794,12	1,11	5869
Incyte Corporation	INCY	Health Care	1,31	49,63	706,77	0,00	15571

We produce separate sets of regression analyses for the original and trimmed S&P 500 datasets. For the industry sectors from where stocks are trimmed, we produce separate sets for non-trimmed and trimmed datasets. For example, for Health Care sector we first produce a regression set for the original sector components and then we produce another set after removing P/B outlier Nektar Therapeutics (P/B 103,01) and P/E outlier Incyte Corporation (P/E 706,77).

Table 4: Descriptive statistics for the regression variables after trimming 1% of highest P/B and P/E stocks.

	Beta	*PB*	*PE*	*DY*	*MV*
Mean	0,99	5,29	36,71	1,87	38313
Standard Error	0,02	0,33	2,06	0,06	2800
Median	0,98	3,22	24,34	1,87	18174
Mode				0,00	
Standard Deviation	0,42	7,04	44,37	1,34	60375
Sample Variance	0,18	49,58	1968,49	1,80	3645129318
Kurtosis	2,60	23,33	41,17	0,22	29,78
Skewness	0,66	4,38	5,52	0,44	4,56
Range	3,48	60,50	455,22	7,99	637950
Minimum	0,02	0,79	10,51	0,00	3686
Maximum	3,50	61,29	465,72	7,99	641636
Sum	459,71	2461,43	17069,91	867,96	17815746
Count	465	465	465	465	465

In Table 4 are presented the S&P 500 descriptive statistics after trimming P/B and P/E outliers. Skewness and kurtosis are significantly reduced for these variables, making their datasets more statistically robust. P/B and P/E means experience a major decrease after trimming, indicating that the trimmed outlier values had a high bias effect to the distributions.

Beta, Dividend Yield and Market Value variables were already initially much less affected by outliers in their distributions, so they do not require trimming for the regression analyses.

6 RESEARCH HYPOTHESES

This chapter introduces our research hypotheses based on previous academic literature.

In our research we do not expect that the independent regression variables would nearly fully explain the determination of betas. As a reminder, this research is not supposed to produce a comprehensive framework for predicting betas using risk factors. What this research is about, is to investigate if and how beta fluctuates in respect to changes in the value and size factor variables. The purpose of this is to make empirical investigation on how an investment portfolio's systematic risk is affected with changes in the portfolio's utilization of value and size anomaly tilts.

Our first 3 hypotheses are related to value factor proxies' P/B, P/E, and DY.

Hypothesis 1: Price-to-Book has a positive association with beta.

Hypothesis 2: Price-to-Earnings has a positive association with beta.

Hypothesis 3: Dividend Yield has a negative association with beta.

A research article which has particularly influenced our hypotheses 1 to 3 is Lakonishok Shleifer & Vishny (1994), who find that in market downturns, value stocks experience less downside risk than growth stocks. Lakonishok et al. investigate the value anomaly overperformance through various differing proxies and their study includes all the value proxies used in our analysis.

Rozeff (1982) finds in his research of U.S. stock market that firms paying high dividend payouts have significantly lower betas. Visscher & Filbeck (2003) find high dividend yield stocks in the Canadian market having superior Treynor ratios, even though their returns are similar to the overall market. This implies that dividend yield is negatively associated with beta in their dataset. Hecht & Vuolteenaho's (2005) study also reinforces the theoretical background of dividend yield having a negative relation to systematic risk.

Relating to the size factor's relation to systematic risk, Fama & French (2006b) find that during the 1926 – 2004 period small firm stocks tended to have higher betas than large firm stock in the U.S. market. This leads to our fourth hypothesis:

Hypothesis 4: Market Value has a negative association with beta.

Next, we will examine the results of our regression analyses. This is done in both S&P 500 and individual sector levels.

7 RESULTS

7.1 Regression results

In this chapter we introduce and discuss the regression results of our study. This is the empirical analysis part of our research. As detailed in Chapter 5, we perform first a regression analysis set for the entire S&P 500 set with complete variable data (N=475). We perform a separate linear regression for each of the independent variables to avoid multicollinearity problems which might bias our results. After this we divide the dataset into sector subsets and perform the same process again for the subsets. We also produce separate regressions after trimming for P/B and P/E outliers. The process is discussed in detail in the Data & Methodology Chapter. The process produces 72 separate regressions in total. For each of the regressions we report the regression coefficient, regression intercept, R-squared, and P-value.

The regression coefficient tells how much a one unit change in the independent variable increases or decreases the value of the dependent variable. The regression equation is intercept +/- coefficient * variable value. For example, if a stocks beta intercept is 0,9, the stock has a P/E of 10 and the regression coefficient for P/E is 0,05, the stock's estimated beta would be 0,9 + 0,05 * 10 = 1,4.

R-squared is the coefficient of determination. It tells how much explanatory power the value of the independent variable has on the value of the dependent variable. Value of 0 tells that the independent variable has no explanatory power at all, while a value of 1 indicates that the dependent variable's values are fully explained by the independent variable.

P-value tells the statistical significance of the regression result. We use a statistical significance level of 95% which is widely utilized in academic research. This means that we report results statistically significant if their P-value is below 0,05.

For the regression analyses, market capitalization values were calculated in billions of USD. In the Appendices 1 and 2 market values are shown in millions of USD. The conversion was made because the regression coefficients were extremely small with millions of USD and often could not be shown with 4 decimal places. The conversion from millions to billions of USD is simply made by dividing the market values by a multiple of 1000. The conversion has no statistical impact on the regression results but makes them more easily interpretable.

Introductory information for the industry sectors utilized in our sector classifications are from the MSCI Global Industry Classification Standards (MSCI Inc., 2018).

Table 5: S&P 500 regression results, no trimming. N=475.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0002	0,9930	0,0007	0,5752
P/E	0,0001	0,9876	0,0017	0,3674
DY	-0,0675	1,1167	0,0470	0,0001
MV	0,0002	0,9834	0,0008	0,5263

Table 6: S&P 500 regression results, P/B & P/E top 1% trimmed. N=465.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0039	1,0090	0,0042	0,1637
P/E	-0,0002	0,9944	0,0003	0,7205
DY	-0,0658	1,1115	0,0443	0,0001
MV	0,0002	0,9811	0,0008	0,5454

In the table 5 regression results for the entire S&P 500 dataset (excluding Appendix 2 stocks), we can see that the results for P/B, P/E and MV variables are not statistically significant. When we investigate the R-squared and P-values, we can conclude that for the U.S. large cap equity market, Price-to-Earnings ratio, Price-to-Book ratio and market capitalization seem to have practically zero predictive power on systematic risk.

The regression result for dividend yield (DY) is statistically significant at both 95% and 99% significance levels (P-value = 0,0000018). This implies that S&P 500 stocks paying high dividend yields should ceteris paribus have lower systematic risk than their counterparts paying lower dividends. The regression result suggests that 4,7% of the systematic risk a stock is exposed to is determined by dividend yield. The regression coefficient tells that in the dataset in general, every 1% increase in DY decreases beta by 0,0675.

In table 6 we can see the P/B and P/E outlier trimmed S&P 500 dataset. Trimming of the outliers does highly affect the P/B and P/E P-values, but still neither of their effects are statistically significant. DY remains the only statistically significant beta predictor.

Next, we will introduce and discuss the regression results for individual sectors. The sectors are here listed in alphabetic order. Full listing of stocks and variables can be seen in Appendix 1 if the reader wants to investigate for example sector compositions.

For sectors where outliers have been trimmed there will be presented two tables, non-trimmed and trimmed. For the rationale of trimming and overall regression methodology and statistical choices see Chapter 5.

Table 7: Consumer discretionary. N=74.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0003	1,0388	0,0107	0,3810
P/E	0,0000	1,0332	0,0000	0,9855
DY	-0,0170	1,0604	0,0050	0,5474
MV	0,0005	1,0187	0,0046	0,5662

Table 8: Consumer discretionary, trimmed. N=72.

Independent variable	Coefficient	Intercept	R Squared	P-value
P/B	-0,0014	1,0530	0,0015	0,7429
P/E	0,0000	1,0448	0,0001	0,9261
DY	-0,0084	1,0563	0,0012	0,7693
MV	0,0004	1,0317	0,0030	0,6489

Consumer discretionary sector consist of companies offering consumer goods in which demands are dependable on the state of economy. Consumer discretionary goods are non-essential to buy for consumers, but their demand increases when basic needs are first met. The consumer discretionary sector in S&P 500 consists from such varied firms as for example Amazon, Netflix, Ford, General Motors and McDonald’s.

In the consumer discretionary regression set we can see that none of the regression results are statistically significant, in fact they are far from the significance level altogether (P-values 0,38 – 0,98). From this we can conclude that it seems that our independent variables hold no power in explaining systematic risk in the consumer discretionary sector. One potential reason for the extremely low explanatory power between the variables might be the composition of the sector, since the firms comprising it have very different characteristics in common.

Trimming for P/E and P/B outliers does not make any of the regressions statistically significant. On the contrary, the trimmed results show higher P-values than non-trimmed, indicating that the few outliers had a biasing effect on the results. Overall it can be concluded that for the Consumer Discretionary sector our variables seem to be not related or extremely weakly related to beta.

Table 9: Consumer staples. N=30.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0015	0,6743	0,0084	0,6296
P/E	-0,0076	0,8474	0,0330	0,3367
DY	-0,0294	0,7228	0,0124	0,5578
MV	0,0004	0,0570	0,0136	0,5387

Consumer staples sector consists of firms which produce goods that have a relatively stable demand through economic cycles. Consumer staples products are essential to consumers regardless of their financial situation. Consumer staples sector contains for example Coca-Cola, Procter & Gamble, Altria and Walmart.

As was the case with consumer discretionary, the regression results show also for the consumer staples sector that the regression variables have poor explanatory power and lack statistically significant P-values. Thus, it seems that in the sector the size and value factors are not correlated (or have at least extremely small correlation) with the systematic risk. Consumer Staples sector does not contain stocks which were trimmed in the outlier removal.

Table 10: Energy. N=30.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0113	1,4448	0,0067	0,6661
P/E	0,0000	1,4115	0,0001	0,9640
DY	-0,0049	1,4199	0,0003	0,9310
MV	-0,0008	1,4444	0,0139	0,5351

Table 11: Energy, trimmed. N=29.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0113	1,4438	0,0068	0,6713
P/E	-0,0010	1,4528	0,0068	0,6695
DY	-0,0045	1,4182	0,0002	0,9394
MV	-0,0008	1,4433	0,0139	0,5421

Energy sector comprises of companies in the oil, gas, and coal industries, and companies serving these industries. They include for example Exxon Mobil, Chevron, and Schlumberger.

The regression set for Energy sector does not result in any statistically significant results. The high regression intercepts show that Energy sector as a whole is exposed to higher than average systematic risk, but the size and value factors are incapable in explaining systematic risk variation among the different stocks in the sector. Outlier trimming has a reducing effect on the P/E regression P-value, but it still remains far from statistical significance.

Table 12: Financials. N=64.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0018	1,1851	0,0022	0,7137
P/E	0,0000	1,1777	0,0002	0,9140
DY	-0,0535	1,2766	0,0157	0,3238
MV	0,0009	1,1436	0,0180	0,2909

Table 13: Financials, trimmed. N=63.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0061	1,1949	0,0098	0,4399
P/E	-0,0017	1,2170	0,0107	0,4196
DY	-0,0533	1,2758	0,0155	0,3314
MV	0,0009	1,1426	0,0181	0,2930

Financials sector comprises from banks, insurance companies, investment companies and asset managers. It contains such names as Berkshire Hathaway, Goldman Sachs, Bank of America, and Citigroup.

The regression results for Financials sector do not show any statistically significant results. R-squared statistics are low and P-values high, implying that the size and value factors have poor prediction power in explaining systematic risk among financial stocks.

Outlier trimming increases R-squared and decreases P-values for P/B and P/E regressions, meaning that the outlier removal makes the regressions a better fit, but they still are not statistically significant.

Table 14: Health care. N=61.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	0,0046	0,8119	0,0470	0,0932
P/E	0,0009	0,8028	0,0689	0,0410
DY	-0,0426	0,8867	0,0201	0,2756
MV	0,0004	0,8300	0,0055	0,5699

Table 15: Health care, trimmed. N=59.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	0,0081	0,7901	0,0271	0,2127
P/E	0,0025	0,7414	0,0522	0,0819
DY	-0,0342	0,8687	0,0132	0,3858
MV	0,0006	0,8107	0,0102	0,4455

The Health Care sector comprises of companies providing health care services, equipment, technology, and pharmaceuticals. Health Care sector contains for example Johnson & Johnson, Pfizer, Merck & Co, and CVS Health.

The regression results for Health Care sector show that P/E has a 6,9% explanatory power on beta with a 95% significance level (P=0,0410). The P/E regression coefficient is 0,0009, meaning that P/E seems to have a small but positive correlation on systematic risk. P/B regression shows a P-value of 0,0932, while DY and MV regressions are far from statistical significance (P=0,2756, 0,5699).

However, after trimming P/B and P/E outliers, the prior significance of the P/E regression is reduced to a P-value of 0,0819, meaning that the positive relation between P/E and beta is no longer statistically significant. The significance was boosted by outliers with high P/E and beta values. After trimming, it seems that our independent variables have only a weak correlation with systematic risk and no statistical significance.

Table 16: Industrials. N=65.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0006	1,1130	0,0014	0,7679
P/E	0,0005	1,0905	0,0192	0,2707
DY	-0,0548	1,2009	0,0217	0,2420
MV	0,0000	1,1073	0,0000	0,9776

Table 17: Industrials, trimmed. N=62.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0310	1,2431	0,1077	0,0092
P/E	0,0034	1,0173	0,0149	0,3440
DY	-0,0525	1,1907	0,0193	0,2813
MV	0,0001	1,1015	0,0000	0,9581

Industrials sector comprises of manufacturing, machinery, infrastructure, aerospace and defense industries. For example, Boeing, General Electric, 3M, and Lockheed Martin are part of the Industrials sector.

None of the regressions for Industrials sector show statistical significance, implying that the size and value factors do not seem to be viable predictors of systematic risk in the sector.

However, trimming for P/B and P/E outliers alters the regression results much more than for other sectors. P/B regression becomes statistically significant with a P-value of 0,0092. P/B has a negative relationship with Beta. The coefficient is rather small, -0,0310, but it has a reasonably high R-squared of 0,1077.

Table 18: Information technology. N=74.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	0,0019	1,0675	0,0020	0,7271
P/E	0,0000	1,0779	0,0004	0,8746
DY	-0,0013	1,0809	0,0000	0,9604
MV	0,0000	1,0798	0,0000	0,9724

Table 19: Information technology, trimmed. N=73.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	0,0019	1,0674	0,0020	0,7304
P/E	0,0008	1,0461	0,0177	0,2986
DY	-0,0012	1,0806	0,0000	0,9648
MV	0,0000	1,0796	0,0000	0,9729

Information technology sector comprises of firms producing IT services, software, hardware, semiconductors, and electronics. The sector experienced changes in the September 2018 overhaul of GICS standards by MSCI and some of its components were transferred to a newly formed Communications sector. Before the overhaul Information Technology sector was the largest S&P 500 sector by market capitalization. We have used the old MSCI classification in our study. The sector includes for example Apple, Microsoft, Facebook, Alphabet, Visa, and NVIDIA.

The regression results for Information Technology sector show extremely small R-squared values (0,0000 – 0,0020) and high P-values (0,7271 – 0,9724). We believe that with these results it is safe to say that in practice P/B, P/E, DY, and MV variables do not have any predictive power on systematic risk in the Information Technology sector. Trimming outliers does not change the situation much since it does not make any of the regression results statistically significant.

Table 20: Materials. N=23.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	-0,0258	1,4176	0,0506	0,3022
P/E	-0,0037	1,4160	0,0505	0,3027
DY	0,2276	0,8435	0,1202	0,1051
MV	0,0001	1,2793	0,0000	0,9924

Materials sector consists of chemicals, gases, metals, paper, and mining companies. For example, Monsanto, Praxair, FMC and Albemarle are part of the Materials sector. Monsanto merged with Bayer AG after our dataset was collected.

The regression coefficients for Materials sector seem counter-intuitive: P/E and P/B variables have a negative relation with systematic risk while DY has a positive relation. However, none of the Materials sector regressions are statistically significant.

Table 21: Real Estate. N=33.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	0,0003	0,6849	0,0000	0,9803
P/E	-0,0011	0,7646	0,0324	0,3163
DY	-0,0790	0,9457	0,0873	0,0951
MV	-0,0041	0,7572	0,0183	0,4529

The Real Estate sector consists of various kinds of REIT companies (Real Estate Investment Trust) and real estate development and services companies. Stocks included in the Real Estate sector are for example, American Tower Corporation, Simon Property Group, and Realty Income.

None of the regression analyses for the sector show statistical significance, with P-values between 0,0951 and 0,9803. DY seems to be the best predictor with its R-squared of 0,0873 and 0,0951 P-value. We find it surprising that P/B has zero predictive power on the systematic risk (R-squared=0,9803, P-value=0,9803) in an industry where the book value of equity is arguably more important than in many other industries.

The results are in line with Kim, Gu & Mattila (2002) who investigated US Hotel REIT's systematic risk determinants and tested dividend yield and market value but found no statistically significant relationship. Overall the Real Estate sector stocks have noticeably low betas as can be seen from the intercepts.

Table 22: Utilities. N=28.

Independent variable	Coefficient	Intercept	R-squared	P-value
P/B	0,0287	0,2948	0,0028	0,7874
P/E	0,0064	0,1713	0,4546	0,0001
DY	-0,1195	0,7738	0,1300	0,0594
MV	-0,0077	0,5079	0,1898	0,0205

Utilities sector companies produce and distribute electricity, gas, and water. Utilities sector consists of for example Duke Energy, Edison International, and American Water Works. As can be seen from Table 22, the regression intercepts are extremely low for Utilities sector, implying that the sector as a whole is exposed to lower than average systematic risk.

Regression analyses for P/E (P=0,0001) and MV (P=0,0205) are statistically significant. Also, R-squared values are rather high, with 0,4546 for P/E and 0,1898 for MV. The regression shows a positive relationship with P/E and systematic risk and a negative relation with MV. Also, DY regression appears to contain information with a R-squared value of 0,1300, but it slightly fails to be statistically significant with a P-value of 0,0594.

7.2 Discussion

We performed regression analysis sets to determine the relationship of systematic risk with size and value factors. We performed separate regressions to each of the variables, P/B, P/E, DY, and MV to avoid possible multicollinearity. Regressions were made for the entire S&P 500 and the different sectors composing it. P/B and P/E variables showed highly skewed distributions with large positive outliers. To avoid outlier bias, we trimmed 1% of the highest P/B and P/E observations from the S&P 500. These same stocks were eliminated also from the sector compositions where they belonged. We provided regression coefficients, regression intercepts, R-squared values, and P-values for each of the regressions. For those datasets which were trimmed of outliers, we provide the statistics for both trimmed and non-trimmed datasets.

The regressions made for the entire S&P 500 dataset indicate that dividend yield is negatively related to the systematic risk of stocks. The results are statistically significant in both, the trimmed and the non-trimmed regressions with 95% and 99% significance levels. The trimmed regression intercept shows that for a non-dividend paying company in the S&P 500, beta is on average 1,1115, and with every 1% increase in its dividend yield, beta decreases by 0,0658. Thus, for example a company paying a 3% dividend yield has on average a beta of 0,9141 and a company paying a 6% dividend yield has on average a beta of 0,7167. R-squared indicates however, that dividend yield determines only 4,43% of the variation in beta, thus implying that the regression residuals are high, and there is a wide range of variation in the level of systematic risk even for a similar dividend yield paying companies. The results for the non-trimmed S&P 500 results are closely similar.

Although the R-squared for the S&P 500 DY regression is relatively low, the regression coefficient is relatively high, as the effects on beta seen in the previous example with 3% and 6% yielding stocks are notable. This indicates that in addition to being statistically significant, the negative relation between dividend yield and systematic risk is also practically meaningful.

Price-to-Book, Price-to-Earnings, and Market Value regressions of the S&P 500 do not produce statistically significant results. Also, their R-squared values are extremely low. From this we can conclude that P/B, P/E and MV do not appear to have any notable relation with beta.

The sector specific regression sets for Consumer Discretionary, Consumer Staples, Energy, Financials, Information Technology, Materials, and Real Estate sectors did not produce statistically significant results. Thus, it seems that size and value factors are not related to the systematic risk variation between intra-industry firms in these sectors.

The regression set for Health Care sector initially showed a statistically significant positive relation between Price-to-Earnings variable and systematic risk with a 95% significance level. However, after trimming for outliers, the regression lost its statistical significance, implying that the strong relation was highly affected by the removed outliers.

The non-trimmed regression set for Industrials sector does not show any statistically significant results, but after trimming for outliers, Price-to-Book regression produces a statistically significant relation with 95% and 99% significance levels. Opposite to our hypotheses, P/B has a negative relation with beta in the regression. This means in practice that in the Industrials sector, companies with higher than average P/B ratios were exposed to lower than average systematic risk during our research period.

Utilities sector's regression set produces two statistically significant results; Price-to-Earnings is positively related to systematic risk and Market Value is negatively related to systematic risk. P/E regression is statistically significant at the 99% level and shows a high R-squared of 0,4546, implying that 45% of the beta variation in the Utilities sector is determined by the level of a company's P/E ratio. The MV regression is statistically significant at the 95% level and its R-squared indicates that 19% of the beta variation in the sector is explained by the market capitalization of a firm.

Overall, 6 out of a total of 72 regressions conducted in our empirical analysis resulted in statistically significant outcomes. We view this result as evidence that the value and size factors do not seem to be correlated with systematic risk at a large scale.

Perhaps the most meaningful result of our study is the negative relation of dividend yield with beta in the whole sample regression sets. This result indicates that on average, the higher dividend yield a stock is paying, the lower its beta is. The effect of dividend yield decreasing systematic risk is significant both statistically and practically, since the regression coefficient is quite large.

An interesting observation is, that even though the DY regression was statistically significant for the entire S&P 500 dataset, none of the sector specific DY regressions were statistically significant. This implies that dividend yield has explanatory power on systematic risk across the S&P 500, but not so much between different stocks of a given industry. This might indicate that the effect is explained by different sectors having on average differing betas and dividend yields, so that low beta sectors have on average high dividend yields, and high beta sectors have on average low dividend yields. This would explain the mixed results between our entire dataset regressions and sector specific regression sets.

A possible reason for the statistically significant positive P/E regression in Utilities sector might be that because of the defensiveness and stableness of the sector, there are less other beta determinants (e.g. growth) than on other sectors, which leads to price multiples having a larger effect on the level of systematic risk.

The statistically significant negative MV regression in Utilities sector, and negative P/B regression in Industrials sector might be caused by some actual determinants, or they can equally well be results of randomness. A significant relation between beta and market value was not observed in any other regression set than the Utilities sector, and similarly P/B regression were not statistically significant in any other sector than the industrials. Of course, also the P/E regression result for Utilities sector could be caused by randomness, but for this regression there exists better theoretical background to possibly explain the result.

Overall, most of our regressions lack statistical significance, implying that in general the value and size factors do not appear to be strongly related to systematic risk. However, if value factor is proxied by dividend yield, it has a decreasing effect on systematic risk, although this effect seems to be also related to sector differences. Thus, we conclude that our results indicate that value and size factors do not seem to be correlated with systematic risk, except if dividend yield is used as a value factor metric, in which case it has a systematic risk decreasing effect.

Our research hypotheses 1, 2, and 4 relating to P/B, P/E, and MV associations with beta are inconclusive. Overall, our empirical analysis does not show statistically or practically significant results that would either confirm nor reject these hypotheses.

Hypothesis 3 is confirmed by our empirical analysis. Across the S&P 500 dividend yield does indeed have a negative association with systematic risk. This effect seems to be related to sector differences, and the effect does not show on sector level regressions.

8 SUMMARY & CONCLUSIONS

The purpose of our research was to investigate whether loading an investment portfolio with securities utilizing value and size factors would influence the level of the portfolio's systematic risk. This was conducted by testing if beta is related to value factor proxies Price-to-Book ratio (P/B), Price-to-Earnings ratio (P/E), and Dividend Yield (DY) or the size factor as represented by company's stock market capitalization (MV) in the S&P 500 stock market index. The question is relevant since risk factor-based investment strategies have gained widespread attention during recent years.

The empirical analysis was done by linear regression analysis, where beta is the dependent variable and the different value and size factor proxies are independent variables. The independent variables were tested on separate regressions to avoid multicollinearity.

Regressions were made for the entire S&P 500 dataset, and separately to each individual sector as classified by MSCI GICS standards pre-September 2018 changes. Telecom sector was excluded because of low number of observations. Individual stocks with missing variables were removed. P/B and P/E variables had large outliers, which were trimmed. Both trimmed and non-trimmed regression results were shown. For further detail of research methodology and process, see Chapter 5.

Across the S&P 500 dataset, Price-to-Book, Price-to-Earnings, and Market Value variables did not produce statistically or practically significant regression results. The regression result for dividend yield is statistically significant at 99% significance level (P-value = 0,0000018). This implies that S&P 500 stocks paying high dividend yields are on average exposed to lower systematic risk than their counterparts paying lower dividends yields. The trimmed regression intercept shows that for a non-dividend paying company in the S&P 500, beta is on average 1,1115, and with every 1% increase in its dividend yield, beta decreases by 0,0658. Thus, for example a company paying a 3% dividend yield has on average a beta of 0,9141 and a company paying a 6% dividend yield has on average a beta of 0,7167. R-squared indicates however, that dividend yield determines only 4,43% of the variation in beta, thus implying that the regression residuals are high, and there is a wide range of variation in the level of systematic risk even for similar dividend yield paying companies. The results for the non-trimmed S&P 500 regressions are closely similar. The large regression coefficient in the S&P 500 dividend yield regression shows that the effect of dividend yield decreasing beta is in addition to statistical significance also practically significant.

The negative association of dividend yield with beta did not appear statistically significant in sector specific regressions. This seems to implicate that the effect might be caused by sector differences. Dividend yield has explanatory power on systematic risk across the S&P 500, but not so much between different stocks of a given industry. This might indicate that the effect is explained by different sectors having on average differing betas and dividend yields, so that low beta sectors have on average high dividend yields, and high beta sectors have on average low dividend yields. This would explain the mixed results between our entire dataset regressions and sector specific regression sets. In practice this means that high-dividend yield stocks often operate in defensive sectors of the economy.

We also found individual statistically significant relationships between value factor and size factor proxies in the sector specific regressions, but their results were mixed and overall only 6 of our entire set of 72 regressions returned statistically significant results. Because of the mixed and statistically weak results in sector specific regressions, we conclude that the aforementioned negative association between dividend yield and systematic risk across S&P 500 is the only practically significant and reliable finding in our research.

We refrain from making further conclusions from the sector specific regressions, since no clear trends were spotted between the variables. Trying to explain the mixed and contradictory sector specific regressions might be a too aggressive way of interpreting the results. Because of the lack of any clear trends, the few statistically significant sector specific results might just as well be caused by spurious regressions.

The finding of dividend yield having a negative association to beta supports prior research evidence by Rozeff (1982), Lakonishok Shleifer & Vishny (1994), Visscher & Filbeck (2003), and Hecht & Vuolteenaho (2005). However, contrary to Lakonishok et al. (1994) study, which found all the value factor proxies (P/B, P/E, and DY) to be risk reducing, our study found this effect only from the dividend yield.

Fama & French (1993; 1996) and Malkiel (2014) argue that the historical excess returns of factor-based investment strategies are explained by these strategies carrying a higher risk versus the overall market. Our study's findings do not support this view. We did not find value or size factor proxies to be systematic risk increasing variables. Dividend yield oppositely had a systematic risk decreasing effect.

The results of our research can be summarized in that value factor proxies P/B ratio and P/E ratio, and size factor as represented by market capitalization do not overall have statistically or practically significant relation to the level of systematic risk, neither across the entire S&P 500 or within separate sectors. Value factor proxy dividend yield has a negative relation with systematic risk across S&P 500 stocks, which is significant both statistically and practically. However, this effect is not found within separate sector analyses, indicating that the effect across S&P 500 is explained by different sectors having on average differing betas and dividend yields, so that low beta sectors have on average high dividend yields, and high beta sectors have on average low dividend yields.

As the goal of our study was to answer to the question if loading an investment portfolio with securities utilizing value and size factor anomalies would have an effect on the level of the portfolio's systematic risk, our answer based on our regression analyses is that the factors do not seem to be related to the level of systematic risk. Price-to-Book, Price-to-Earnings, and market capitalization variables were not shown to either increase nor decrease systematic risk. If value factor is represented by dividend yield, it has a systematic risk decreasing effect, but not between stocks of a mutual industry sector.

The results of our study are relevant to investors considering factor investing strategies. Our research's results show that factor investment strategies utilizing value and size anomalies in the U.S. large capitalization equity market are not exposed to higher systematic risk than the overall market. Further research would be useful to conduct on the equity markets of various other countries. Systematic risk association studies could also be made for other factors used in the construction of Smart Beta products. Econometric limitations of our research and how they are addressed are discussed extensively in Chapter 5.

The results of this study support the usage of factor investment strategies as a part of an investment portfolio. The results should be viewed in light of the vast academic literature showing overperforming long-term average returns by value and size factor strategies. A major criticism of factor strategies is that the factors serve as proxies for additional risk. Considering our results, value and size factor-based investment strategies do not expose a portfolio to heightened systematic risk.

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APPENDICES

Appendix 1. S&P 500 full variables dataset.

S&P 500 stocks used for the regression analyses. Sources: Stock listing for S&P 500 from SPY ETF holdings list 24.5.2018, regression variables data from Thomson Reuters Datastream 25.5.2018. N = 475. Dividend yield in percentages, market value in millions of USD.

Company	Identifier	Sector	Beta	P/B	P/E	DY	MV
Apple Inc.	AAPL	Information Technology	1,09	5,00	14,69	1,92	641636,09
Microsoft Corporation	MSFT	Information Technology	1,00	5,72	24,69	2,58	436897,46
Amazon.com Inc.	AMZN	Consumer Discretionary	1,25	17,07	465,72	0,00	310360,75
Facebook Inc. Class A	FB	Information Technology	1,37	5,98	163,63	0,00	238668,62
JPMorgan Chase & Co.	JPM	Financials	1,31	1,15	12,50	2,58	259177,25
Berkshire Hathaway Inc. Class B	BRK.B	Financials	0,81	1,39	18,54	0,00	178307,22
Exxon Mobil Corporation	XOM	Energy	1,11	2,09	20,89	3,34	368247,10
Alphabet Inc. Class A	GOOGL	Information Technology	0,89	3,91	35,67	0,00	235175,15
Johnson & Johnson	JNJ	Health Care	0,85	4,47	20,43	2,77	302359,90
Bank of America Corp	BAC	Financials	1,57	0,83	21,24	1,14	194995,42
Intel Corporation	INTC	Information Technology	1,05	2,52	14,92	3,06	160447,69
Chevron Corporation	CVX	Energy	1,42	1,39	28,52	3,92	209433,98
Wells Fargo & Company	WFC	Financials	1,28	1,52	13,02	2,81	262408,93
Visa Inc. Class A	V	Information Technology	1,12	6,48	35,97	0,72	144960,36
UnitedHealth Group Incorporated	UNH	Health Care	0,74	3,22	19,32	1,55	126952,43
Home Depot Inc.	HD	Consumer Discretionary	1,01	50,36	23,02	2,11	153627,16
Pfizer Inc.	PFE	Health Care	0,78	2,95	30,95	3,55	201878,21
Cisco Systems Inc.	CSCO	Information Technology	1,21	2,36	16,06	3,20	147578,71
AT&T Inc.	T	Telecommunication Services	0,41	1,85	20,52	5,26	208883,27
Verizon Communications Inc.	VZ	Telecommunication Services	0,48	9,12	25,72	4,57	191623,13
Boeing Company	BA	Industrials	1,27	144,07	21,56	2,60	108088,32
Procter & Gamble Company	PG	Consumer Staples	0,66	3,73	22,24	3,18	220475,81
Citigroup Inc.	C	Financials	1,57	0,79	13,95	0,68	158852,60
Mastercard Incorporated Class A	MA	Information Technology	1,06	18,63	30,30	0,65	109526,31
AbbVie Inc.	ABBV	Health Care	0,83	28,53	24,92	3,48	103415,39
Coca-Cola Company	KO	Consumer Staples	0,65	7,90	27,41	3,15	183733,30
Merck & Co. Inc.	MRK	Health Care	0,64	3,82	31,25	3,22	160072,89
Walt Disney Company	DIS	Consumer Discretionary	1,25	3,50	20,06	1,30	156489,36
Netflix Inc.	NFLX	Consumer Discretionary	1,11	17,98	246,68	0,00	48277,54
NVIDIA Corporation	NVDA	Information Technology	1,27	6,43	32,48	1,25	41154,81
Comcast Corporation Class A	CMCSA	Consumer Discretionary	1,20	2,70	18,96	1,72	139321,77
PepsiCo Inc.	PEP	Consumer Staples	0,68	11,22	23,35	2,83	145010,32
Oracle Corporation	ORCL	Information Technology	1,10	3,49	18,20	1,44	176088,94
McDonald's Corporation	MCD	Consumer Discretionary	0,75	9,05	21,75	3,07	105255,02
General Electric Company	GE	Industrials	1,10	2,68	32,78	3,31	246294,45

International Business Machines Corporation	IBM	Information Technology	0,99	10,00	12,67	3,15	162053,96
Adobe Systems Incorporated	ADBE	Information Technology	0,93	6,58	81,38	0,00	50598,36
Walmart Inc.	WMT	Consumer Staples	0,64	3,00	16,96	2,62	239729,12
Amgen Inc.	AMGN	Health Care	1,12	4,23	18,39	2,31	111712,77
3M Company	MMM	Industrials	1,12	8,50	21,69	2,46	103367,20
Medtronic plc	MDT	Health Care	0,74	2,24	26,71	2,02	92902,00
Union Pacific Corporation	UNP	Industrials	1,17	3,84	19,07	2,16	85583,10
Honeywell International Inc.	HON	Industrials	0,96	4,72	20,44	2,05	85194,68
Texas Instruments Incorporated	TXN	Information Technology	1,38	6,17	22,74	2,61	64621,59
Abbott Laboratories	ABT	Health Care	1,28	2,89	33,60	2,13	70396,25
Altria Group Inc	MO	Consumer Staples	0,57	19,24	18,01	4,19	107715,27
Booking Holdings Inc.	BKNG	Consumer Discretionary	1,06	7,32	30,96	0,00	69761,53
Broadcom Inc.	AVGO	Information Technology	0,77	4,81	51,35	1,70	50803,25
Schlumberger NV	SLB	Energy	1,31	2,84	61,45	2,32	108010,26
Accenture Plc Class A	ACN	Information Technology	0,77	9,46	20,34	2,09	66445,98
United Technologies Corporation	UTX	Industrials	1,31	3,17	16,06	2,32	95217,83
Caterpillar Inc.	CAT	Industrials	1,37	3,90	53,99	3,13	58795,61
NIKE Inc. Class B	NKE	Consumer Discretionary	0,98	7,06	26,67	1,20	69018,05
Gilead Sciences Inc.	GILD	Health Care	1,13	6,91	16,54	1,45	119587,12
salesforce.com inc.	CRM	Information Technology	1,09	8,65	3275,78	0,00	49750,71
QUALCOMM Incorporated	QCOM	Information Technology	1,03	2,95	18,86	3,13	100398,09
Costco Wholesale Corporation	COST	Consumer Staples	0,87	5,75	28,16	1,11	64655,93
Thermo Fisher Scientific Inc.	TMO	Health Care	1,01	2,55	30,65	0,45	55922,10
Bristol-Myers Squibb Company	BMY	Health Care	0,89	6,82	39,77	2,63	95845,81
Goldman Sachs Group Inc.	GS	Financials	1,32	1,08	12,31	1,34	80418,82
Starbucks Corporation	SBUX	Consumer Discretionary	0,75	13,29	461,82	1,43	73644,42
Lockheed Martin Corporation	LMT	Industrials	0,60	23,70	18,33	3,02	66914,44
ConocoPhillips	COP	Energy	1,76	1,75	12,14	3,47	70427,02
Lowe's Companies Inc.	LOW	Consumer Discretionary	1,13	8,38	24,00	1,68	62477,50
Eli Lilly and Company	LLY	Health Care	0,37	5,82	29,59	2,89	80073,07
U.S. Bancorp	USB	Financials	1,08	1,90	14,40	2,32	78381,73
United Parcel Service Inc. Class B	UPS	Industrials	0,92	88,77	33,67	2,87	72470,48
NextEra Energy Inc.	NEE	Utilities	0,17	2,24	19,38	2,92	52184,04
Morgan Stanley	MS	Financials	1,58	1,02	17,65	1,65	69678,24
American Express Company	AXP	Financials	1,09	3,87	15,50	1,47	78594,53
Time Warner Inc.	TWX	Consumer Discretionary	0,81	2,48	17,40	1,80	65942,80
Micron Technology Inc.	MU	Information Technology	1,16	1,98	14,85	0,00	28112,02
PNC Financial Services Group Inc.	PNC	Financials	0,98	1,19	13,55	2,19	50356,93
Charles Schwab Corporation	SCHW	Financials	1,46	3,41	30,83	0,85	43880,02
EOG Resources Inc.	EOG	Energy	1,44	3,35	940,39	0,67	50726,47
BlackRock Inc.	BLK	Financials	1,69	2,03	18,97	2,44	59949,58
CVS Health Corporation	CVS	Health Care	0,96	2,40	19,56	1,87	91445,75
Occidental Petroleum Corporation	OXY	Energy	1,01	2,27	71,20	3,86	60602,89
Danaher Corporation	DHR	Health Care	0,94	2,35	22,29	0,54	58242,37
Raytheon Company	RTN	Industrials	0,56	3,78	18,36	2,26	38287,94
FedEx Corporation	FDX	Industrials	1,44	3,05	26,39	0,67	47623,61

Chubb Limited	CB	Financials	0,94	1,25	13,64	2,26	47804,80
Biogen Inc.	BIIB	Health Care	1,51	6,16	25,30	0,00	67537,15
Celgene Corporation	CELG	Health Care	1,30	12,58	45,21	0,00	81171,41
Becton Dickinson and Company	BDX	Health Care	0,79	4,00	39,50	1,69	33440,68
American Tower Corporation	AMT	Real Estate	0,67	9,02	58,73	1,79	43800,14
Mondelez International Inc. Class A	MDLZ	Consumer Staples	0,88	2,29	25,89	1,72	63591,38
Anthem Inc.	ANTM	Health Care	0,81	1,54	15,43	1,64	38470,92
Automatic Data Processing Inc.	ADP	Information Technology	1,09	8,97	27,72	2,34	41778,82
Bank of New York Mellon Corporation	BK	Financials	1,37	1,22	16,78	1,77	45170,85
General Dynamics Corporation	GD	Industrials	0,87	4,01	18,41	2,00	46735,40
Northrop Grumman Corporation	NOC	Industrials	0,70	5,40	17,71	1,83	35867,64
Aetna Inc.	AET	Health Care	0,37	2,50	20,12	1,09	38666,38
CSX Corporation	CSX	Industrials	1,56	2,72	18,77	2,09	34314,53
Stryker Corporation	SYK	Health Care	0,64	4,33	35,77	1,39	40354,99
TJX Companies Inc	TJX	Consumer Discretionary	0,43	9,97	21,13	1,30	46023,50
Monsanto Company	MON	Materials	0,99	7,70	25,48	1,84	51889,32
Colgate-Palmolive Company	CL	Consumer Staples	0,82	41,10	30,85	2,23	61089,57
CME Group Inc. Class A	CME	Financials	0,43	1,61	27,55	2,23	34256,10
Walgreens Boots Alliance Inc	WBA	Consumer Staples	1,01	2,87	24,09	1,95	76745,25
Activision Blizzard Inc.	ATVI	Information Technology	1,08	3,10	30,09	0,79	27244,58
Valero Energy Corporation	VLO	Energy	0,96	1,38	11,06	3,05	29641,02
Applied Materials Inc.	AMAT	Information Technology	1,29	3,79	24,05	1,73	31825,40
Duke Energy Corporation	DUK	Utilities	0,23	1,31	22,59	4,32	53643,14
Intuitive Surgical Inc.	ISRG	Health Care	0,45	5,54	38,10	0,00	24721,30
S&P Global Inc.	SPGI	Financials	1,23	61,90	5097,84	1,35	28956,27
Deere & Company	DE	Industrials	0,99	3,90	15,07	2,45	33320,03
Allergan plc	AGN	Health Care	0,60	1,57	55,10	0,45	72139,63
Charter Communications Inc. Class A	CHTR	Consumer Discretionary	0,84	43,37	48,55	0,00	42945,77
Phillips 66	PSX	Energy	1,04	1,85	15,21	2,72	43402,79
MetLife Inc.	MET	Financials	1,32	1,08	41,72	2,92	54830,40
Simon Property Group Inc.	SPG	Real Estate	0,64	12,44	35,31	3,42	54934,40
General Motors Company	GM	Consumer Discretionary	1,71	1,37	13,19	3,57	52889,26
American International Group Inc.	AIG	Financials	1,10	0,85	172,15	1,53	67582,15
Intuit Inc.	INTU	Information Technology	1,32	17,72	39,70	1,09	28481,01
Emerson Electric Co.	EMR	Industrials	1,33	4,49	21,50	3,15	39937,86
Capital One Financial Corporation	COF	Financials	1,51	0,88	11,17	1,85	41655,32
Illinois Tool Works Inc.	ITW	Industrials	1,28	7,48	18,93	2,11	39868,51
Halliburton Company	HAL	Energy	1,40	3,58	54,36	1,49	40867,48
Ford Motor Company	F	Consumer Discretionary	1,24	1,96	10,64	4,12	54006,98
Praxair Inc.	PX	Materials	1,04	6,62	22,57	2,30	36197,08
Cognizant Technology Solutions Corporation Class A	CTSH	Information Technology	0,87	3,80	23,16	0,19	34906,78
Southern Company	SO	Utilities	0,07	2,00	29,39	4,70	43593,78
Norfolk Southern Corporation	NSC	Industrials	1,61	2,27	17,28	2,36	30649,93
Express Scripts Holding Company	ESRX	Health Care	1,10	2,61	23,33	0,00	49849,27
BB&T Corporation	BBT	Financials	1,14	1,27	15,51	2,73	30765,06

Cigna Corporation	CI	Health Care	0,82	2,67	17,37	0,03	33514,08
Prudential Financial Inc.	PRU	Financials	1,43	1,43	22,73	2,87	39726,93
Crown Castle International Corp	CCI	Real Estate	0,35	4,24	116,77	3,08	30730,13
Boston Scientific Corporation	BSX	Health Care	0,71	3,86	102,83	0,00	25870,88
Marsh & McLennan Companies Inc.	MMC	Financials	0,90	4,62	20,80	2,07	32319,90
Dominion Energy Inc	D	Utilities	0,24	3,19	37,28	3,78	43468,91
Intercontinental Exchange Inc.	ICE	Financials	0,58	1,99	30,45	1,28	28740,65
Marriott International Inc. Class A	MAR	Consumer Discretionary	1,32	8,58	28,01	1,33	25380,93
Zoetis Inc. Class A	ZTS	Health Care	0,80	17,35	39,52	0,77	23273,64
Twenty-First Century Fox Inc. Class A	FOXA	Consumer Discretionary	1,38	3,89	16,42	1,05	38993,36
Humana Inc.	HUM	Health Care	0,47	2,53	21,28	0,78	25876,91
Electronic Arts Inc.	EA	Information Technology	0,74	5,53	84,96	0,00	20926,48
Vertex Pharmaceuticals Incorporated	VRTX	Health Care	1,16	20,56	173,66	0,00	26371,78
Illumina Inc.	ILMN	Health Care	0,56	12,15	73,52	0,00	23919,74
Exelon Corporation	EXC	Utilities	0,41	1,20	17,56	3,76	30640,47
Target Corporation	TGT	Consumer Discretionary	1,01	3,14	16,59	3,25	40898,09
Ecolab Inc.	ECL	Materials	0,87	4,71	31,80	1,13	34152,39
LyondellBasell Industries NV	LYB	Materials	1,46	4,98	13,28	3,45	41063,21
Marathon Petroleum Corporation	MPC	Energy	1,42	2,00	14,97	2,53	25991,77
State Street Corporation	STT	Financials	1,18	1,57	15,67	1,82	30427,99
Constellation Brands Inc. Class A	STZ	Consumer Staples	0,17	3,85	25,62	0,62	23218,46
Kimberly-Clark Corporation	KMB	Consumer Staples	0,78	49,95	28,74	3,12	42050,08
HP Inc.	HPQ	Information Technology	1,72	2,07	11,30	2,71	42590,44
Progressive Corporation	PGR	Financials	0,62	2,93	16,69	2,03	20075,23
Air Products and Chemicals Inc.	APD	Materials	1,06	3,69	31,72	2,47	29567,77
Baxter International Inc.	BAX	Health Care	0,59	3,57	17,75	1,88	32356,18
Travelers Companies Inc.	TRV	Financials	0,97	1,41	11,42	2,29	33231,91
Aflac Incorporated	AFL	Financials	0,84	1,84	10,70	2,38	29004,66
Anadarko Petroleum Corporation	APC	Energy	1,67	2,58	53,18	0,88	36951,30
eBay Inc.	EBAY	Information Technology	0,96	3,81	106,97	0,00	49442,78
Aon plc	AON	Financials	0,98	4,93	22,09	1,11	28239,53
Delta Air Lines Inc.	DAL	Industrials	1,18	2,82	12,73	1,35	33192,98
Analog Devices Inc.	ADI	Information Technology	1,41	3,30	37,87	2,61	21027,04
Eaton Corp. Plc	ETN	Industrials	1,47	1,96	16,83	3,16	31818,12
Fidelity National Information Services Inc.	FIS	Information Technology	0,69	2,45	37,69	1,55	21554,19
Prologis Inc.	PLD	Real Estate	0,91	1,68	72,51	3,26	24601,42
Allstate Corporation	ALL	Financials	0,99	1,45	13,28	1,85	27433,60
Estee Lauder Companies Inc. Class A	EL	Consumer Staples	0,71	8,38	29,74	1,23	20256,22
Waste Management Inc.	WM	Industrials	0,55	4,58	56,52	2,84	26298,25
Lam Research Corporation	LRCX	Information Technology	1,23	2,63	30,79	1,03	16050,60
American Electric Power Company Inc.	AEP	Utilities	0,30	1,67	23,19	3,74	29246,07
Pioneer Natural Resources Company	PXD	Energy	1,37	2,86	97,72	0,06	25959,78
SunTrust Banks Inc.	STI	Financials	1,39	1,02	13,65	2,06	23035,99

Johnson Controls International plc	JCI	Industrials	0,91	2,75	36,34	2,10	24395,03
Ross Stores Inc.	ROST	Consumer Discretionary	0,72	8,06	21,20	0,97	21261,67
Sherwin-Williams Company	SHW	Materials	0,88	16,27	27,89	1,04	26004,99
Sysco Corporation	SYY	Consumer Staples	0,51	7,72	27,16	2,85	25073,33
Public Storage	PSA	Real Estate	0,44	6,88	35,20	3,34	34771,17
Equinix Inc.	EQIX	Real Estate	0,57	5,06	195,39	1,40	20092,48
Autodesk Inc.	ADSK	Information Technology	1,22	9,57	84,64	0,00	15609,74
Kinder Morgan Inc Class P	KMI	Energy	1,31	1,86	117,84	4,02	48191,49
Fiserv Inc.	FISV	Information Technology	0,81	7,19	27,39	0,00	20620,49
McKesson Corporation	MCK	Health Care	1,21	4,18	22,54	0,65	38721,02
Red Hat Inc.	RHT	Information Technology	1,01	10,35	67,76	0,00	14382,61
T. Rowe Price Group	TROW	Financials	1,34	3,87	17,59	2,56	20302,92
Roper Technologies Inc.	ROP	Industrials	1,06	3,26	28,55	0,61	18368,84
Moody's Corporation	MCO	Financials	1,20	43,58	31,08	1,33	20810,02
Edwards Lifesciences Corporation	EW	Health Care	0,51	6,59	30,12	0,00	16900,69
DXC Technology Co.	DXC	Information Technology	0,72	2,57	112,62	1,26	12067,53
Yum! Brands Inc.	YUM	Consumer Discretionary	0,83	25,32	25,77	2,01	30778,21
Southwest Airlines Co.	LUV	Industrials	0,98	3,04	18,64	0,83	25463,05
Weyerhaeuser Company	WY	Real Estate	1,54	2,92	34,35	3,57	20549,25
Discover Financial Services	DFS	Financials	1,44	2,31	11,42	1,84	25174,98
ONEOK Inc.	OKE	Energy	1,34	19,88	35,17	5,02	12435,66
M&T Bank Corporation	MTB	Financials	1,17	1,44	16,74	2,20	19276,02
V.F. Corporation	VFC	Consumer Discretionary	0,82	5,50	24,34	2,21	26639,02
Sempra Energy	SRE	Utilities	0,27	2,12	22,04	2,84	25657,38
Amphenol Corporation Class A	APH	Information Technology	0,83	5,34	24,70	0,93	18494,18
PPG Industries Inc.	PPG	Materials	1,31	5,23	18,97	1,45	27429,30
Alexion Pharmaceuticals Inc.	ALXN	Health Care	1,64	5,68	106,02	0,00	30419,12
Aptiv PLC	APTV	Consumer Discretionary	1,71	7,55	16,80	1,38	21031,36
Public Service Enterprise Group Inc	PEG	Utilities	0,44	1,63	20,68	3,84	21142,21
Carnival Corporation	CCL.U	Consumer Discretionary	0,62	1,55	21,98	2,59	27943,46
Western Digital Corporation	WDC	Information Technology	1,02	2,01	22,57	2,43	19946,99
Archer-Daniels-Midland Company	ADM	Consumer Staples	1,13	1,39	17,97	2,59	26150,28
Dollar General Corporation	DG	Consumer Discretionary	0,68	3,65	19,25	0,80	21089,65
General Mills Inc.	GIS	Consumer Staples	0,73	6,68	21,50	3,22	33097,91
Corning Inc	GLW	Information Technology	1,43	1,45	16,13	2,31	24968,73
Consolidated Edison Inc.	ED	Utilities	0,02	1,49	17,21	3,92	20468,90
Parker-Hannifin Corporation	PH	Industrials	1,42	3,37	19,23	1,87	18174,45
Freeport-McMoRan Inc.	FCX	Materials	3,50	2,32	16,77	2,21	23018,15
Cummins Inc.	CMI	Industrials	1,22	3,24	16,23	2,63	24098,45
Rockwell Automation Inc.	ROK	Industrials	1,25	6,92	21,87	2,17	17063,09
Northern Trust Corporation	NTRS	Financials	1,22	1,98	19,96	1,96	17253,54
O'Reilly Automotive Inc.	ORLY	Consumer Discretionary	0,78	16,36	24,97	0,00	20512,10
PACCAR Inc	PCAR	Industrials	1,32	3,04	20,57	1,51	21681,21
Ingersoll-Rand Plc	IR	Industrials	1,47	1,45	32,77	1,82	18259,83
Align Technology Inc.	ALGN	Health Care	1,54	8,05	54,92	0,00	7897,93
Zimmer Biomet Holdings Inc.	ZBH	Health Care	0,77	2,28	53,10	0,85	20375,09

Regeneron Pharmaceuticals Inc.	REGN	Health Care	1,10	11,02	74,79	0,00	39371,00
Xcel Energy Inc.	XEL	Utilities	0,18	1,77	18,42	3,51	19083,18
International Paper Company	IP	Materials	1,69	4,06	23,21	3,36	20742,54
Fifth Third Bancorp	FITB	Financials	1,40	1,17	11,37	2,46	17522,44
Equity Residential	EQR	Real Estate	0,47	2,33	25,01	3,16	23948,80
Williams Companies Inc.	WMB	Energy	1,47	4,01	73,63	5,36	27064,68
Dollar Tree Inc.	DLTR	Consumer Discretionary	0,55	5,01	28,82	0,00	16775,04
PG&E Corporation	PCG	Utilities	0,18	1,53	23,81	3,21	25886,47
Rockwell Collins Inc.	COL	Industrials	0,90	4,86	19,01	1,42	13247,27
Stanley Black & Decker Inc.	SWK	Industrials	1,04	2,56	21,27	2,06	17097,21
Microchip Technology Incorporated	MCHP	Information Technology	0,92	4,73	57,09	2,70	12363,00
Dr Pepper Snapple Group Inc.	DPS	Consumer Staples	0,40	6,45	20,20	2,55	14914,68
AvalonBay Communities Inc.	AVB	Real Estate	0,42	2,27	56,30	3,13	21996,88
Kroger Co.	KR	Consumer Staples	1,23	4,28	17,12	1,50	27648,18
Devon Energy Corporation	DVN	Energy	2,36	2,22	24,04	1,24	21901,45
Digital Realty Trust Inc.	DLR	Real Estate	0,45	2,95	63,43	4,51	12811,87
KeyCorp	KEY	Financials	1,45	1,19	14,87	2,08	14206,21
Centene Corporation	CNC	Health Care	0,64	2,56	24,97	0,00	9146,67
Regions Financial Corporation	RF	Financials	1,47	0,92	13,75	1,95	14773,04
Ameriprise Financial Inc.	AMP	Financials	1,47	2,82	14,85	2,33	20144,32
Newmont Mining Corporation	NEM	Materials	0,85	1,43	155,63	1,09	15162,29
Paychex Inc.	PAYX	Information Technology	1,00	9,92	26,68	3,26	18721,10
Concho Resources Inc.	CXO	Energy	1,32	2,35	49,71	0,00	15433,24
Willis Towers Watson Public Limited Company	WLTW	Financials	0,77	2,81	30,93	2,16	12921,52
Welltower Inc.	WELL	Real Estate	0,38	1,79	112,47	5,01	22768,17
Andeavor	ANDV	Energy	1,36	1,76	15,06	2,11	10801,28
Tyson Foods Inc. Class A	TSN	Consumer Staples	0,77	1,98	15,91	1,06	15316,14
Agilent Technologies Inc.	A	Health Care	1,13	3,51	31,45	0,99	16693,17
Monster Beverage Corporation	MNST	Consumer Staples	0,61	8,01	42,60	0,00	23232,50
Nucor Corporation	NUE	Materials	1,46	2,11	27,52	2,95	16469,00
Edison International	EIX	Utilities	0,23	1,83	33,11	2,83	20823,32
Mylan N.V.	MYL	Health Care	1,11	3,17	31,10	0,00	21068,10
WEC Energy Group Inc	WEC	Utilities	0,17	2,11	20,08	3,44	15178,12
PPL Corporation	PPL	Utilities	0,50	2,06	18,88	4,52	22543,12
Hartford Financial Services Group Inc.	HIG	Financials	1,08	1,16	25,64	1,82	17353,45
Ventas Inc.	VTR	Real Estate	0,29	2,12	44,46	4,69	20898,85
SBA Communications Corp. Class A	SBAC	Real Estate	0,67	28,71	230,67	0,00	14211,05
Cerner Corporation	CERN	Health Care	0,96	5,12	39,79	0,00	20281,85
Harris Corporation	HRS	Industrials	0,73	3,90	35,63	2,28	10597,10
NetApp Inc.	NTAP	Information Technology	1,21	3,65	28,32	1,94	11657,59
Skyworks Solutions Inc.	SWKS	Information Technology	0,94	3,95	21,14	0,85	13613,55
Boston Properties Inc.	BXP	Real Estate	0,77	3,34	39,97	2,25	18786,59
Royal Caribbean Cruises Ltd.	RCL	Consumer Discretionary	0,84	1,88	40,22	1,86	17434,70
DTE Energy Company	DTE	Utilities	0,27	1,76	18,86	3,45	15612,51
Best Buy Co. Inc.	BBY	Consumer Discretionary	1,15	3,08	13,69	2,55	13243,15

Global Payments Inc.	GPN	Information Technology	1,11	4,62	33,50	0,08	9196,81
Marathon Oil Corporation	MRO	Energy	2,59	0,99	12,25	2,33	16842,31
Motorola Solutions Inc.	MSI	Information Technology	0,59	4,79	20,56	2,13	14504,15
E*TRADE Financial Corporation	ETFC	Financials	1,52	1,41	28,64	0,00	8269,34
CenturyLink Inc.	CTL	Telecommunication Services	1,20	1,14	23,84	7,99	17372,73
Textron Inc.	TXT	Industrials	1,26	2,27	18,74	0,20	11523,69
Noble Energy Inc.	NBL	Energy	1,60	1,87	22,84	1,30	17951,68
IDEXX Laboratories Inc.	IDXX	Health Care	0,62	35,16	43,48	0,00	9017,36
KLA-Tencor Corporation	KLAC	Information Technology	1,34	12,78	19,69	2,83	12140,21
Eversource Energy	ES	Utilities	0,42	1,58	19,16	3,29	16567,03
Laboratory Corporation of America Holdings	LH	Health Care	0,49	2,64	20,80	0,00	12190,73
Xilinx Inc.	XLNX	Information Technology	0,75	5,22	23,37	2,45	13286,85
AMETEK Inc.	AME	Industrials	1,13	3,70	23,80	0,65	12922,31
CBS Corporation Class B	CBS	Consumer Discretionary	1,23	6,56	21,85	1,09	25252,14
Comerica Incorporated	CMA	Financials	1,65	1,27	17,64	1,69	9817,52
United Continental Holdings Inc.	UAL	Industrials	1,22	3,50	13,41	0,00	18783,27
SVB Financial Group	SIVB	Financials	1,71	2,22	21,92	0,00	7151,49
Seagate Technology PLC	STX	Information Technology	1,39	7,21	16,41	5,27	14333,21
Omnicom Group Inc	OMC	Consumer Discretionary	1,01	6,92	17,30	2,71	18196,91
Huntington Bancshares Incorporated	HBAN	Financials	1,46	1,37	14,75	2,50	10257,43
Vulcan Materials Company	VMC	Materials	1,21	2,70	98,17	0,52	12333,45
Verisk Analytics Inc	VRSK	Industrials	0,81	17,56	28,77	0,00	12599,12
Hess Corporation	HES	Energy	2,19	1,15	186,66	1,63	19810,32
Cardinal Health Inc.	CAH	Health Care	0,95	3,63	28,65	2,18	23968,01
MGM Resorts International	MGM	Consumer Discretionary	0,92	2,39	42,23	0,37	13418,97
W.W. Grainger Inc.	GWW	Industrials	0,92	6,48	21,94	2,00	14883,34
Host Hotels & Resorts Inc.	HST	Real Estate	1,29	1,99	36,23	3,92	14151,70
National Oilwell Varco Inc.	NOV	Energy	0,90	1,14	11,95	1,96	20528,80
Kellogg Company	K	Consumer Staples	0,44	10,31	32,78	2,95	23992,10
Eastman Chemical Company	EMN	Materials	1,22	2,74	14,09	2,06	11769,93
Apache Corporation	APA	Energy	1,54	3,22	18,35	1,74	23713,26
Republic Services Inc.	RSG	Industrials	0,58	2,08	26,04	2,59	16440,12
Principal Financial Group Inc.	PFG	Financials	1,42	1,48	36,44	2,92	15236,38
Wynn Resorts Limited	WYNN	Consumer Discretionary	1,53	33,56	36,21	2,36	13965,58
Cintas Corporation	CTAS	Industrials	0,85	4,87	23,52	1,13	10614,95
Waters Corporation	WAT	Health Care	0,76	5,30	23,55	0,00	11205,64
L3 Technologies Inc	LLL	Industrials	0,99	2,20	22,21	2,00	11089,99
Brown-Forman Corporation Class B	BF.B	Consumer Staples	0,86	12,23	29,02	1,32	11522,03
Conagra Brands Inc.	CAG	Consumer Staples	0,46	3,70	25,11	2,58	15903,47
Essex Property Trust Inc.	ESS	Real Estate	0,47	2,45	55,21	2,83	13059,90
Clorox Company	CLX	Consumer Staples	0,38	61,29	24,18	2,79	14739,00
Lincoln National Corporation	LNC	Financials	1,96	1,03	11,28	1,64	13469,25
Baker Hughes a GE Company Class A	BHGE	Energy	1,27	5,87	30,21	1,38	22524,25
Fastenal Company	FAST	Industrials	0,93	6,92	27,17	2,53	13361,94

FirstEnergy Corp.	FE	Utilities	0,29	2,09	42,51	4,57	14459,29
XL Group Ltd	XL	Financials	0,37	1,03	18,17	2,02	10063,49
Realty Income Corporation	O	Real Estate	0,48	2,10	48,36	4,63	12628,76
IQVIA Holdings Inc	IQV	Health Care	0,60	2,20	44,61	0,00	11559,79
Mettler-Toledo International Inc.	MTD	Health Care	1,22	17,79	29,67	0,00	10209,95
Ulta Beauty Inc	ULTA	Consumer Discretionary	0,44	7,49	36,13	0,00	11151,78
American Water Works Company Inc.	AWK	Utilities	0,25	2,18	25,13	2,28	11206,70
MSCI Inc. Class A	MSCI	Financials	0,74	14,40	30,55	0,91	7483,74
ResMed Inc.	RMD	Health Care	0,43	4,95	25,84	1,91	8869,47
Expedia Group Inc.	EXPE	Consumer Discretionary	1,20	4,24	47,50	0,87	13275,00
Total System Services Inc.	TSS	Information Technology	1,12	4,38	26,46	0,98	8783,09
CBRE Group Inc. Class A	CBRE	Real Estate	1,60	3,84	22,04	0,00	10941,41
Entergy Corporation	ETR	Utilities	0,40	1,52	18,93	4,60	13345,81
D.R. Horton Inc.	DHI	Consumer Discretionary	0,97	1,70	14,94	0,99	10797,92
Ameren Corporation	AEE	Utilities	0,33	1,62	19,81	3,72	11268,90
United Rentals Inc.	URI	Industrials	2,19	4,29	20,20	0,00	8762,10
AmerisourceBergen Corporation	ABC	Health Care	1,18	13,34	116,13	1,47	18633,64
Lennar Corporation Class A	LEN	Consumer Discretionary	1,15	1,68	15,57	0,35	8892,48
ANSYS Inc.	ANSS	Information Technology	0,81	3,89	35,26	0,00	8722,24
Citrix Systems Inc.	CTXS	Information Technology	1,11	6,89	35,77	0,00	11982,43
Quest Diagnostics Incorporated	DGX	Health Care	0,52	2,34	17,24	2,03	10930,78
Martin Marietta Materials Inc.	MLM	Materials	1,24	2,57	40,18	1,09	9943,02
Loews Corporation	L	Financials	0,85	0,84	62,02	0,58	15641,35
Equifax Inc.	EFX	Industrials	0,85	4,62	29,26	1,24	12105,11
Genuine Parts Company	GPC	Consumer Discretionary	1,13	4,12	19,87	2,77	13601,49
Ball Corporation	BLL	Materials	0,74	5,56	33,13	0,84	10575,37
Akamai Technologies Inc.	AKAM	Information Technology	1,26	3,33	35,16	0,00	10344,36
Mohawk Industries Inc.	MHK	Consumer Discretionary	0,97	2,49	23,67	0,00	13769,16
Synopsys Inc.	SNPS	Information Technology	0,99	2,64	37,78	0,00	8322,38
Expeditors International of Washington Inc.	EXPD	Industrials	0,77	4,81	23,58	1,47	9284,59
Raymond James Financial Inc.	RJF	Financials	1,58	1,81	17,82	1,28	8782,26
Symantec Corporation	SYMC	Information Technology	0,38	3,70	17,45	2,06	15934,35
Nektar Therapeutics	NKTR	Health Care	1,08	103,01	138,82	0,00	3175,60
Xylem Inc.	XYL	Industrials	1,28	3,51	27,23	1,40	8016,09
GGP Inc.	GGP	Real Estate	0,82	2,81	36,23	3,01	22017,41
Tiffany & Co.	TIF	Consumer Discretionary	1,50	3,69	30,96	1,95	10990,87
Hershey Company	HSY	Consumer Staples	0,68	20,59	32,73	2,31	15397,03
Take-Two Interactive Software Inc.	TTWO	Information Technology	1,11	4,66	268,87	0,00	4503,17
CMS Energy Corporation	CMS	Utilities	0,22	2,55	20,10	3,26	10371,04
PVH Corp.	PVH	Consumer Discretionary	0,62	1,93	25,45	0,14	9201,97
Alexandria Real Estate Equities Inc.	ARE	Real Estate	0,91	1,79	84,77	3,34	7723,89
Tapestry Inc.	TPR	Consumer Discretionary	0,92	4,36	20,19	3,33	11700,19
Dover Corporation	DOV	Industrials	1,35	3,07	18,40	2,14	12752,16
CarMax Inc.	KMX	Consumer Discretionary	1,53	3,55	20,67	0,00	11492,68
EQT Corporation	EQT	Energy	0,58	2,20	83,97	0,17	12366,00

J. M. Smucker Company	SJM	Consumer Staples	0,51	2,00	22,38	2,59	13076,18
C.H. Robinson Worldwide Inc.	CHRW	Industrials	0,61	8,41	21,18	2,32	10143,90
McCormick & Company Incorporated	MKC	Consumer Staples	0,44	5,67	24,60	1,97	10020,41
Arthur J. Gallagher & Co.	AJG	Financials	0,92	2,49	23,50	3,02	8404,29
Newell Brands Inc	NWL	Consumer Discretionary	0,62	3,37	30,82	2,06	14166,80
Cadence Design Systems Inc.	CDNS	Information Technology	1,13	6,75	37,03	0,00	6956,02
Gartner Inc.	IT	Information Technology	0,95	46,85	50,18	0,00	7945,63
Masco Corporation	MAS	Industrials	1,05	10,52	27,39	1,30	9817,02
Kansas City Southern	KSU	Industrials	1,18	2,75	24,71	1,25	10945,79
Church & Dwight Co. Inc.	CHD	Consumer Staples	0,57	5,15	26,99	1,64	10973,94
Extra Space Storage Inc.	EXR	Real Estate	0,43	4,06	36,31	3,49	8507,73
Incyte Corporation	INCY	Health Care	1,31	49,63	706,77	0,00	15570,97
Zions Bancorporation	ZION	Financials	1,36	1,02	20,29	0,84	6742,47
Cboe Global Markets Inc	CBOE	Financials	0,67	13,77	33,47	1,32	6647,24
FMC Corporation	FMC	Materials	1,30	4,37	84,02	1,07	8477,85
Vornado Realty Trust	VNO	Real Estate	0,91	3,55	41,89	2,93	17601,23
Invesco Ltd.	IVZ	Financials	1,43	1,71	16,30	3,14	14382,88
Packaging Corporation of America	PKG	Materials	1,36	4,30	18,13	2,76	7582,67
Molson Coors Brewing Company Class B	TAP	Consumer Staples	0,81	1,61	20,06	2,05	14036,03
Kohl's Corporation	KSS	Consumer Discretionary	1,14	1,72	13,64	3,72	10011,90
Whirlpool Corporation	WHR	Consumer Discretionary	1,34	2,67	17,31	2,16	12572,87
F5 Networks Inc.	FFIV	Information Technology	1,05	6,19	24,88	0,00	8136,29
Henry Schein Inc.	HSIC	Health Care	1,14	4,07	24,99	0,00	11694,89
Franklin Resources Inc.	BEN	Financials	1,58	2,27	14,77	1,51	27255,47
CA Inc.	CA	Information Technology	0,95	2,34	17,20	3,24	13501,31
Varian Medical Systems Inc.	VAR	Health Care	0,85	5,26	24,27	0,00	8699,23
J.B. Hunt Transport Services Inc.	JBHT	Industrials	1,11	7,00	24,47	0,97	9802,99
Norwegian Cruise Line Holdings Ltd.	NCLH	Consumer Discretionary	1,11	2,46	31,51	0,00	10156,86
CenterPoint Energy Inc.	CNP	Utilities	0,54	2,49	25,23	4,25	10258,79
Cooper Companies Inc.	COO	Health Care	0,66	2,97	30,82	0,04	8376,88
Chipotle Mexican Grill Inc.	CMG	Consumer Discretionary	1,08	8,66	84,01	0,00	14820,27
Hologic Inc.	HOLX	Health Care	0,70	3,98	82,96	0,00	9253,01
Darden Restaurants Inc.	DRI	Consumer Discretionary	0,45	3,94	19,71	3,51	8397,72
Nasdaq Inc.	NDAQ	Financials	0,87	1,65	31,84	1,73	9469,20
Advanced Micro Devices Inc.	AMD	Information Technology	1,96	14,31	48,56	0,00	5457,34
DENTSPLY SIRONA Inc.	XRAY	Health Care	0,95	2,43	26,17	0,56	10016,00
HCP Inc.	HCP	Real Estate	0,29	2,18	45,42	5,58	16613,74
Cabot Oil & Gas Corporation	COG	Energy	0,72	5,34	100,60	0,41	12216,40
NRG Energy Inc.	NRG	Utilities	1,16	1,63	150,70	1,63	7415,07
Cincinnati Financial Corporation	CINF	Financials	0,82	1,94	18,06	3,14	9989,28
Albemarle Corporation	ALB	Materials	1,30	2,88	25,79	1,62	7988,62
Macy's Inc	M	Consumer Discretionary	0,79	2,86	13,66	3,58	14952,21
Huntington Ingalls Industries Inc.	HII	Industrials	0,82	4,19	17,72	1,14	6821,77
Michael Kors Holdings Ltd	KORS	Consumer Discretionary	0,86	5,53	18,16	0,00	11084,47
Alliance Data Systems Corporation	ADS	Information Technology	1,33	8,20	29,65	0,30	13866,87

Qorvo Inc.	QRVO	Information Technology	1,67	1,70	216,54	0,00	6549,20
BorgWarner Inc.	BWA	Consumer Discretionary	1,84	2,97	26,57	1,13	10700,39
Universal Health Services Inc. Class B	UHS	Health Care	0,36	2,48	17,79	0,32	9890,66
Mid-America Apartment Communities Inc.	MAA	Real Estate	0,30	1,80	51,70	3,83	7312,53
Nielsen Holdings Plc	NLSN	Industrials	0,78	3,45	32,39	2,63	15787,63
Hasbro Inc.	HAS	Consumer Discretionary	0,84	5,34	21,15	2,73	9275,46
DaVita Inc.	DVA	Health Care	0,87	2,89	27,71	0,00	14151,41
Perrigo Co. Plc	PRGO	Health Care	0,48	2,28	80,04	0,50	16671,90
Duke Realty Corporation	DRE	Real Estate	0,82	2,21	59,40	3,39	7588,84
International Flavors & Fragrances Inc.	IFF	Materials	0,79	5,75	23,90	1,85	9240,78
Tractor Supply Company	TSCO	Consumer Discretionary	1,13	7,10	26,70	1,13	9861,91
Mosaic Company	MOS	Materials	1,56	1,32	27,25	2,58	12299,28
Viacom Inc. Class B	VIAB	Consumer Discretionary	1,58	5,30	11,14	2,37	20233,27
Avery Dennison Corporation	AVY	Materials	1,02	5,92	22,10	2,32	6214,96
Torchmark Corporation	TMK	Financials	0,91	1,57	13,89	0,88	7718,44
CF Industries Holdings Inc.	CF	Materials	1,37	2,52	18,05	2,79	10294,84
IPG Photonics Corporation	IPGP	Information Technology	1,27	3,80	23,79	0,00	5689,78
A. O. Smith Corporation	AOS	Industrials	1,44	4,51	794,12	1,11	5869,35
Hormel Foods Corporation	HRL	Consumer Staples	0,41	3,80	23,86	1,77	16173,98
Juniper Networks Inc.	JNPR	Information Technology	1,17	1,98	21,86	1,29	10287,24
Iron Mountain Inc.	IRM	Real Estate	1,22	7,02	56,05	5,38	7644,96
UDR Inc.	UDR	Real Estate	0,54	3,03	140,72	3,45	8539,70
Western Union Company	WU	Information Technology	1,00	8,18	19,23	3,23	9458,70
Affiliated Managers Group Inc.	AMG	Financials	1,57	3,40	24,80	0,13	9853,90
Alliant Energy Corp	LNT	Utilities	0,35	2,02	19,84	3,37	7653,30
Everest Re Group Ltd.	RE	Financials	0,65	1,27	10,51	2,10	8469,11
Interpublic Group of Companies Inc.	IPG	Consumer Discretionary	0,90	3,93	19,44	2,51	8428,44
LKQ Corporation	LKQ	Consumer Discretionary	0,94	2,91	24,07	0,00	9399,07
Advance Auto Parts Inc.	AAP	Consumer Discretionary	0,91	3,97	22,66	0,19	9820,12
Cimarex Energy Co.	XEC	Energy	1,55	3,49	21,65	0,47	10121,77
L Brands Inc.	LB	Consumer Discretionary	0,81	1066,91	19,13	3,21	18978,26
Snap-on Incorporated	SNA	Industrials	1,09	3,26	18,50	1,63	8278,89
SL Green Realty Corp.	SLG	Real Estate	0,92	1,54	71,77	2,40	10253,96
Fortune Brands Home & Security Inc.	FBHS	Industrials	1,22	3,29	33,06	1,15	8145,28
Pinnacle West Capital Corporation	PNW	Utilities	0,34	1,64	17,81	3,63	7667,47
Federal Realty Investment Trust	FRT	Real Estate	0,50	5,13	49,27	2,80	9063,18
NiSource Inc	NI	Utilities	0,45	1,80	26,28	2,87	9385,52
Regency Centers Corporation	REG	Real Estate	0,61	2,88	227,69	3,22	7150,52
Robert Half International Inc.	RHI	Industrials	1,00	6,03	20,72	1,76	6310,03
PulteGroup Inc.	PHM	Consumer Discretionary	1,00	1,56	13,06	1,42	7328,85
PerkinElmer Inc.	PKI	Health Care	0,92	2,63	31,81	0,56	5838,34
AES Corporation	AES	Utilities	0,97	2,63	35,23	3,09	8521,38
Arconic Inc.	ARNC	Industrials	1,93	1,70	86,94	1,10	12942,18
Ralph Lauren Corporation Class A	RL	Consumer Discretionary	1,14	2,84	31,50	1,67	7403,67

Sealed Air Corporation	SEE	Materials	1,25	22,05	34,15	1,42	8199,94
Jacobs Engineering Group Inc.	JEC	Industrials	1,15	1,50	22,74	0,29	6736,69
Jefferies Financial Group Inc	JEF	Financials	1,27	0,81	44,67	1,20	8513,94
Pentair plc	PNR	Industrials	1,26	2,49	54,01	1,98	11822,33
Helmerich & Payne Inc.	HP	Energy	1,39	1,66	16,53	3,98	7562,49
FLIR Systems Inc.	FLIR	Information Technology	0,80	2,81	25,00	1,38	4813,01
Harley-Davidson Inc.	HOG	Consumer Discretionary	0,95	4,82	15,76	2,30	11090,83
Gap Inc.	GPS	Consumer Discretionary	0,88	4,59	13,78	2,91	13751,49
Alaska Air Group Inc.	ALK	Industrials	0,77	2,92	12,46	1,30	8113,78
Garmin Ltd.	GRMN	Consumer Discretionary	1,08	2,63	19,43	4,17	9362,03
DISH Network Corporation Class A	DISH	Consumer Discretionary	1,19	9,90	31,47	0,00	12619,70
Hanesbrands Inc.	HBI	Consumer Discretionary	0,78	8,56	23,15	1,80	9190,10
Discovery Inc. Class A	DISCA	Consumer Discretionary	1,51	2,43	20,71	0,00	6117,01
Fluor Corporation	FLR	Industrials	1,51	2,58	24,80	1,47	8584,64
Campbell Soup Company	CPB	Consumer Staples	0,36	9,94	24,55	2,66	15330,88
People's United Financial Inc.	PBCT	Financials	0,96	1,04	19,13	4,19	5186,31
Goodyear Tire & Rubber Company	GT	Consumer Discretionary	1,56	2,14	13,86	1,03	7289,36
Kimco Realty Corporation	KIM	Real Estate	0,55	1,90	32,28	4,47	9595,80
Apartment Investment and Management Company Class A	AIV	Real Estate	0,65	4,31	165,49	3,23	5837,34
Xerox Corporation	XRX	Information Technology	1,02	1,44	17,84	2,76	10954,52
Macerich Company	MAC	Real Estate	0,76	2,40	45,23	3,95	10170,82
H&R Block Inc.	HRB	Consumer Discretionary	0,52	105,95	19,64	3,02	7147,22
Foot Locker Inc.	FL	Consumer Discretionary	0,76	2,81	14,99	2,03	7398,47
Newfield Exploration Company	NFX	Energy	2,15	4,00	17,06	0,00	5641,20
Nordstrom Inc.	JWN	Consumer Discretionary	0,90	8,54	18,80	2,55	10586,04
Leggett & Platt Incorporated	LEG	Consumer Discretionary	1,01	4,98	28,35	3,13	5782,08
Flowserve Corporation	FLS	Industrials	1,56	4,05	27,78	1,37	7240,12
TripAdvisor Inc.	TRIP	Consumer Discretionary	1,35	7,79	62,12	0,00	8680,69
Assurant Inc.	AIZ	Financials	0,48	1,20	15,61	2,04	4901,85
Quanta Services Inc.	PWR	Industrials	1,23	1,40	20,82	0,00	5455,84
Stericycle Inc.	SRCL	Industrials	0,37	3,78	35,35	0,00	8856,35
Acuity Brands Inc.	AYI	Industrials	1,20	4,87	33,42	0,34	7311,68
Mattel Inc.	MAT	Consumer Discretionary	1,02	4,38	22,83	5,09	9970,21
Envision Healthcare Corp.	EVHC	Health Care	0,15	1,37	30,29	0,00	3685,71
SCANA Corporation	SCG	Utilities	0,41	1,53	14,59	4,11	8028,94
Under Armour Inc. Class A	UAA	Consumer Discretionary	1,38	7,78	64,05	0,00	8580,49
Range Resources Corporation	RRC	Energy	0,75	2,54	74,03	0,32	8432,14

Appendix 2. Deleted observations due to missing variables.

S&P 500 stocks excluded from the regression analyses due to missing data on some or all variables or having continuously negative P/B ratios. N = 25.

Company	Identifier	Sector	Beta	P/B	P/E	DY	MV
DowDuPont Inc.	DWDP	Materials		0,24	6,00	0,25	23998,75
PayPal Holdings Inc	PYPL	Information Technology		2,25	42,43	0,00	34562,55
Kraft Heinz Company	KHC	Consumer Staples		0,91	63,18	1,74	55810,67
Synchrony Financial	SYF	Financials		1,90	11,64	0,66	19250,55
Hewlett Packard Enterprise Co.	HPE	Information Technology		0,98	37,35	0,75	15750,85
Fortive Corp.	FTV	Industrials		6,32	24,23	0,16	8577,63
Hilton Worldwide Holdings Inc	HLT	Consumer Discretionary		6,39	74,03	0,59	20740,27
Citizens Financial Group Inc.	CFG	Financials		0,58	15,97	1,26	11419,60
American Airlines Group Inc.	AAL	Industrials		6,43	8,25	0,71	22547,39
IHS Markit Ltd.	INFO	Industrials		1,67	54,40	0,00	8647,56
WestRock Co.	WRK	Materials		1,27	48,29	1,77	7882,89
TechnipFMC Plc	FTI	Energy		0,29	0,00	0,19	3889,57
Allegion PLC	ALLE	Industrials		91,05	63,36	0,61	5655,05
News Corporation Class A	NWSA	Consumer Discretionary		0,74	33,01	0,83	5564,59
Brighthouse Financial Inc.	BHF	Financials		0,10	0,00	0,00	1216,36
Navient Corp	NAVI	Financials		1,05	10,34	3,47	4324,02
Coty Inc. Class A	COTY	Consumer Staples		8,64	57,66	1,50	5737,15
Philip Morris International Inc.	PM	Consumer Staples	0,70		19,80	4,36	145198,33
HCA Healthcare Inc	HCA	Health Care	0,35		14,65	0,09	28513,20
AutoZone Inc.	AZO	Consumer Discretionary	0,64		17,76	0,00	19214,76
TransDigm Group Incorporated	TDG	Industrials	0,39		45,85	0,00	11866,15
VeriSign Inc.	VRSN	Information Technology	0,74		25,01	0,00	8579,04
Unum Group	UNM	Financials	1,25	0,00	12,78	1,96	9124,95
Wyndham Worldwide Corporation	WYN	Consumer Discretionary	1,31	0,00	0,00	0,00	0,00
TE Connectivity Ltd.	TEL	Information Technology	1,18	2,72	0,00	1,97	25584,88